COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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COMPRESSED AIR KILLING WEEDS

The half-tone Fig 1 shows in operation one of a comparatively new class of agricultural implements promising valuable results to the farmer. It is for the eradication or control of weeds in the growing crop by spraying with certain chemicals which are said to have a discriminative effect, destroying the weeds without injuring the growing crop. That such a result is actually accomplished seems to be attested by the photo reproduced in Fig. 2 and issued from the Agricultural Experiment Station of Cornell University. This field was infested with wild mustard; the area at the right was sprayed and that at the left was not, with the result shown. On the sprayed area the wild mustard has absolutely disappeared while the grain is developing to perfect maturity.

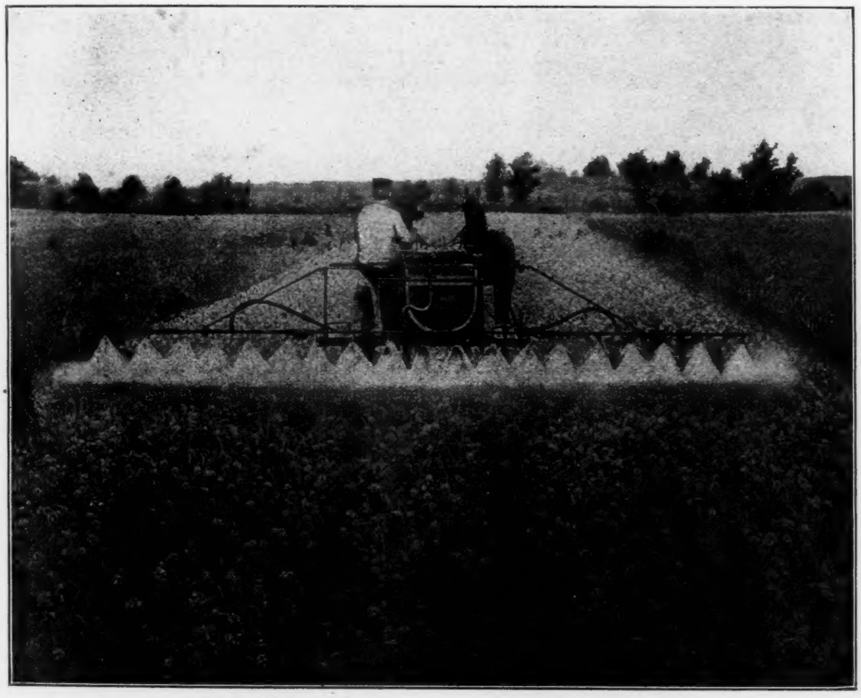

FIG. I.—KILLING THE WEEDS.

The chemical used in this case was sulphate of iron, and Fig. 1 shows the spraying operation. If there should be any suspicion that the jets shown are exaggerated we are not responsible, as this half-tone is reproduced from *Farm Implements*. It is to be understood,

however, that the nozzles are of special design and that a pressure of 100 pounds or so is constantly maintained upon the liquid in the tank. The force imparted by this pressure is said to be very necessary in securing the desired effect. The tank holds from 120 to 150 gallons of the liquid, and the required pressure is maintained by an air compressing pump operated by power from the wheels. These machines are now made by a number of builders with differences of design which it is not necessary to go into. Hand sprayers also are made carrying three or four gallons, they also using compressed air to give force to the jet.

GAYLEY'S INVENTION OF THE DRY BLAST*

By Dr. R. W. Raymond, New York.

The immense commercial value of the Gayley dry blast process has been established beyond controversy. The testimonial of practical blast furnace managers, on both sides of the Atlantic, agrees that it reduces the cost of pig iron about $1 per ton; but from the same testimony it appears that this direct economy does not by any means cover its commercial advantages; in fact, that under present conditions frequently encountered in practice it presents other benefits, of even greater immediate financial importance. To this point I shall recur in a later part of the present paper.

The history of the reception given to this invention, especially on the other side of the Atlantic, has repeated an experience familiar to American engineers. First, the reports of our practice were rejected as theoretically impossible, according to generally accepted notions and formulas; then the figures were reluctantly accepted; and finally the attempt has been made to explain theoretically how they could have been obtained. As to the Gayley dry blast, we Americans have been for several years in the last stage of this discussion, and the rest of the professional world is rapidly coming to it.

Meanwhile, the remark has been repeatedly made, that, whatever Mr. Gayley's process may turn out to be worth, it was not an invention on his part, but simply the energetic and persevering execution of a procedure already proposed by others. This question I wish to discuss in the present paper—What did Mr. Gayley invent?

THE NATURE OF THE INVENTION.

Realizing that this is not the place for a detailed argument on an issue of patent law, I shall not undertake to quote and criticise the publications prior to Mr. Gayley's first patents. It may be admitted, without such critical analysis, that the possible advantages of removing moisture from the air forced into an iron blast furnace were recognized and talked about 100 years ago, and again 50 years ago; that methods and apparatus for cooling air (and incidentally precipitating moisture from it) were known before Mr. Gayley's invention; and that, in one case at least, a system of cooling the blast for a converter had been actually patented. All these prior prophecies and proposals might be shown in detail to be impracticable, defective or visionary; but it is not my present purpose to discuss them. The fact remains that after they had all died out to the last echo, and after the object they sought had been pronounced by high scientific authorities, with the general consent of technical experts, economically unattainable, Mr. Gayley went ahead and did the thing.

This alone might not be conclusive as to his claims, since mere energy and perseverance, however meritorious, do not constitute invention. But this is not all. The significant fact must be added that, after beginning, with all the light that previous investigation and invention could give him, his attempt to carry out the "well-known" operation, Mr. Gayley spent six years in costly experiments before he found out how to do it. This certainly raises a strong presumption that, during those six years, Mr. Gayley discovered something not previously known; and it is that discovery which I wish to define.

All previous plans or suggestions for removing moisture from the blast by reducing its temperature have two features in common:

1. Following the analogy furnished by the natural precipitation of dew, they assume that moisture can be effectively removed from the blast in proportion to the reduction of its temperature to successively lower dew points.

2. They assume that this operation would be metallurgically advantageous in proportion

*A paper read at the meeting of the American Institute of Mining Engineers, at Chattanooga, Tenn., October 2, 1908.

to the extent to which moisture was thus removed. Considering the objectionable effect of such moisture to be a direct function of its amount, they all infer that removing part of the moisture would to that extent remove part of the evil, and that the benefit thus realized would be positive, even if it were but partial.

The first of these assumptions is based upon an incomplete conception of the analogy of nature. Closer observation should have shown these theoretical inventors that the lowering of the temperature of the atmosphere below its dew point does not produce the deposition of dew, except in a quiet atmosphere, because wind prevents the fall of dew and drives it away as fog. Moreover, all the inventions for taking moisture out of air by cooling it deal with bodies of air practically at rest. Nobody before Mr. Gayley had attacked the problem of taking the moisture out of a hurricane in that way; and everybody who had talked, however vaguely, of doing something of the kind with the blast for a furnace had overlooked the circumstance that simply segregating the moisture, by such means, as a mist, and then letting the mist be blown into the furnace, would secure no metallurgical benefit whatever.

WHAT MR. GAYLEY DISCOVERED.

By years of patient experiment Mr. Gayley discovered, and was the first to declare, that if the reduction of temperature were carried to or below the freezing point of water, the ice or snow thus formed could be precipitated as well as segregated; that (with proper proportions of apparatus) it could be practically caught and held, so as to permit a blast free from suspended mist or fog to go forward into the furnace. The amount of aqueous vapor still held in the air would depend, of course, upon its temperature. There would be less of it at 10 degrees below freezing point than at that point. But this small difference has little practical significance. The main point is, that unless the moisture be not only segregated by cooling, but actually solidified, its approximately complete deposition from a rapidly moving current cannot be effected. Practically, therefore, the effect of going below the freezing point is to make sure that that point has been effectively reached in all parts of the current.

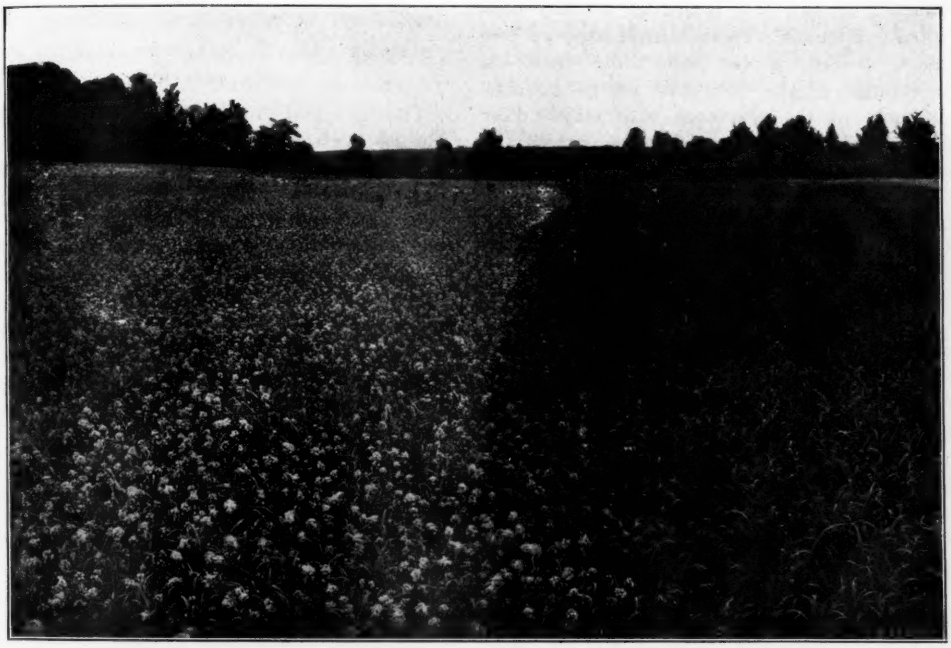

FIG. II.—WEEDS FLOURISHING. WEEDS KILLED.

With regard to the second assumption above stated, it follows from what has been said already that no reliable metallurgical advantage can b secured by cooling. the blast to any temperature short of the freezing point. For under such circumstances, not only might moisture thus segregated be carried onward as mist, but the possible precipitation of a part of it as rain, en route, would introduce a new and serious evil—the evil of uncertainty. This point deserves special discussion.

CERTAINTY A NECESSARY ELEMENT OF AN ART.

The significance of certainty as a necessary element of any real industrial art has been often overlooked. To such loose logic we owe much fascinating but misleading rhetorical celebration of the "lost arts" of the ancients. In spite of the eloquence with which these "lost arts" have been extolled by orators and amateurs, I have been brought by much patient study to the conviction that (as a general rule, at least) no real arts have been lost. For an art is a process which arrives with reasonable certainty, by the intelligent use of definite means, at a desired and foreseen result. This proposition may be made clearer by illustrations. For instance:

Certain ancient tribes are said to have heated iron ore and wood or charcoal together in rude hearths, with the aid of the wind blowing across a mountain top, or of a primitive bellows, supplying an artificial wind, producing thus a half fused conglomerate, out of which could be selected pieces of true steel—indeed, of tool steel or razor steel—of exceptionally high quality. But the assertion that these ancient experimenters had the art of making steel is not justified by any such stories, however authentic. To combine blindly the materials and forces furnished by nature, and then to overhaul the result, seeking for fortunately valuable products, is not to practice an art. Such vague experimenting may be the beginning, out of which, with greater knowledge and the growth of conscious skill, an art may come; but an art it is not. For an art demands the intelligent use of definite means for a definite end.

On the other hand, it is not easy to say at what point a primitive and empirical procedure attains the rank of an art; and it is not necessary for my present purpose to fix that point. The much more important proposition which I wish to emphasize is this—that every industrial process involves the two elements of ignorant dependence upon natural conditions and intelligent control of such conditions, and that the degree of perfection attained by a given art is the degree in which the former element has been superseded by the latter. In practice we try to make a specified product by a given process; yet often, in spite of all our scientific or traditional precautions, a part of our output fails to meet the specifications imposed upon us, and must be rejected; so that, in a general way, it is fair to say that the perfection of an art is measured in inverse ratio to the proportion of such "rejections."

CHEMICAL ANALYSIS HAS REVOLUTIONIZED FURNACE PRACTICE.

The progress of our metallurgical arts toward perfection in this respect has been largely due to the exact determination of the composition of our raw materials. We can all remember when American iron and steel works began to employ chemists of their own, and to determine by chemical analysis not only the character of their products, but also the nature of their ores and fluxes. The result has been a revolutionary transformation of our blast furnace practice. The old "founder," who diagnosed his slag and dosed his furnace accordingly, has disappeared. The superstitious reliance upon this or that brand of ore as a material for this or that brand of iron has gone with him. The chemist dictates the charges and tests the product.

Yet, with all this increase of analytical control, the blast furnace has continued to be, as a great authority once described it, at once the crudest and the most delicate of metallurgical apparatus, subject to inexplicable irregularities, and seemingly obeying whims of its own, beyond the provision or regulation of the most scientific manager.

One reason (and, in my judgment, the chief reason) is that, while we have analyzed ores, fuels and fluxes to the second or third place of decimals, we have practically ignored the composition of the blast which goes into the furnace, although this material constitutes more than half the total weight of the materials charged. This defect in our control of the furnace process has not escaped notice. The effect of varying moisture in the blast has been recognized for 100 years past, especially as

between summer and winter, and furnace managers have adjusted burden and blast in a rude way to meet the conditions thus created. But I do not think that the significance of diurnal and even hourly variations of the moisture in the blast was ever fully recognized until Mr. Gayley called attention to it. At all events, he was the first to propose a practical remedy for the evils resulting from such frequent changes.

The nature of these evils deserves here a preliminary word, especially because it affects profoundly the validity of all our theoretical calculations of heat economy, etc.

THE INFLUENCE OF MOISTURE IN THE BLAST.

The influence of moisture in the blast may be summarized, with sufficient accuracy for my present purpose, as consisting of two elements: (1) The effect of a useless constituent, diluting the effective oxygen of the air and absorbing heat in acquiring the temperature of other materials, and (2) the effect of a constituent which, by its dissociation, absorbs heat in the hearth (where heat is most needed), and either, by the recombination of its elements, restores that heat in another part of the furnace (where it is neither needed nor desired), or else, through incomplete recombination (evidenced by the presence of free hydrogen in the furnace gas), fails to restore a part of the heat it has absorbed.

We are accustomed to determine economy of the blast furnace process by means of thermo-chemical equations and heat balances, in which we take account of the composition, temperature, specific heat, heat of combination or separation, etc., of the materials entering the furnace, and the composition and temperature of the materials escaping from it. With due allowance for the incidental loss of heat by conduction and radiation, this method should be accurate, if the data upon which it rests are accurately determined. That it fails to give us a perfect criterion of our practice is due, in my judgment, to the circumstances that it is necessarily based on averages, and assumes these averages to represent uniform conditions; such and such a quantity, pressure and temperature of blast, composition of ore and flux, and quantity and grade of pig iron produced. These data are usually averaged from considerable periods; in fact, the longer the period taken, the stronger the assumption of the trustworthy character of the calculation —an excellent rule for most purposes, since averages eliminate incidental variations. But when incidental variations are directly influential upon technical and commercial economy, it is not to be hastily assumed that they can counteract one another, so that the average result is equivalent to that of uniform conditions. Suppose, for instance, that a certain temporary change in one factor of the process would have an injurious technical or economical effect, and that a subsequent equal change in the contrary direction would likewise have an injurious effect. Evidently the net result would not be fairly represented by calculations based upon the average conditions of the period embracing both changes, and upon the assumption that they canceled and neutralized each other.

THE "HEAT BALANCE" OF THE BLAST FURNACE.

That this supposed case is not imaginary I shall try to show. But first I would point out another defect in our usual method of stating the "heat balance" of the blast furnace. Our estimates of the utilization and the waste of heat may be practically fair enough, so far as the heat requirements of reduction and fusion, and the loss of heat in slag and gases are concerned; but they are seldom based on accurate data as to the grade of the pig iron actually produced. At least, so far as I now recall, the highest degree of accuracy in that respect does not go beyond a recognition of the general distinction between different grades, from foundry to white iron, or of the special heat requirements of pig iron of peculiar chemical composition (as to silicon, sulphur, manganese, etc.).

The statement that a given furnace is "running on" this or that grade of iron, and the use in calculation of the figures appropriate to that grade, seems to be the best that has been achieved in this regard. But a furnace "running on" a particular kind or grade of iron not only may, but in present practice invariably does, produce more or less iron of other grades (sometimes colloquially called "off iron"), the amount of which, sometimes even exceeding 50 per cent. of the total product, may seriously affect the value of our technical calculations of heat economy, if these do not include it as a factor. I offer this suggestion as a partial explanation of the fact that

such theoretical calculations do not always furnish a safe criterion of alleged or possible technical economies. The method is scientifically sound, but it is applied to data too roughly determined for such precise mathematical discussion. Many of us have heard of the distinguished engineer, of whom it was said that in "duty trials" of engines he "would carry out to the third decimal place the determination of the weight of the ashes, while he guessed at the amount of coal shoveled into the fireplace." Possibly some such inconsistency may explain the hasty conclusions of some foreign experts that the reported technical economy of Mr. Gayley's process was "simply impossible."

THE COMMERCIAL ECONOMY OF THE PROCESS.

As regards commercial economy, on the other hand, there is no room for doubt or contradiction. If a blast furnace is "running on" (*i. e.*, managed with the purpose of producing) a particular kind of pig iron, and if Mr. Gayley's process will deliver it altogether, or to an unprecedented degree, from the risk of producing incidentally another kind, not called for, and probably not desired or not readily salable at a profit, the commercial value of this insurance is beyond measurement by any technical formula that has been, or could be, constructed. The case presented in Mr. Cook's paper on "Experience with the Gayley Dry Blast at the Warwick Furnaces,"* furnishes a striking illustration of this proposition.

As already observed, the testimony from iron works both in the United States and abroad agrees in declaring that the Gayley process reduces the cost of pig iron about $1 per ton; but this saving, though important, is trivial, compared with the commercial advantage of a more effective control of the operation and product of the furnace. To state the case roughly, the Warwick Iron & Steel Company was caught, with innumerable others, in the financial revulsion of 1907, which stopped for a time the market for pig iron. The company had a profitable contract with solvent customers for iron of a special grade; but the old and almost dilapidated furnace which it had kept in blast for the purposes of that contract was running so irregularly that only half —or less—of its product could be delivered under the contract, and the rest would have to be stored as not immediately salable, and, indeed, as never likely to be salable at a price covering the special expenses incurred for the purpose of producing the special, and more costly, grade of product for which the furnace had been burdened and operated.

Under these circumstances, the interest on the capital represented by the "off iron" would have exceeded the profits on the proportion of special iron delivered under the specifications of the contract; and a prudent manager would have been obliged to accept the unwelcome alternative (adopted, in fact, by most of our American merchant furnaces) of sacrificing his pending contract, blowing out his furnace, and submitting to the loss in general expenses, interest, etc., and the even greater damage caused by the scattering of skilled and trusted workmen and the inability to take immediate advantage of a general revival of business, or of a sudden special opportunity for a local resumption of work. These disastrous effects of a suspension of operations are, as I need scarcely say, those most dreaded by technical managers, since, besides their direct financial results, they involve the immeasurable anxiety and responsibility of efficient reorganization.

Fortunately for the Warwick Company it had just completed the installation of an expensive plant for the Gayley process; and the operation of this plant, under all the disadvantages of new and untried apparatus, inexperience of both manager and workmen, and dilapidated condition of the furnace then in blast, enabled the company to raise the proportion of its immediately and profitable marketable product from below 50 to above 80 per cent.; to fill its pending contract; and to realize, instead of industrial demoralization and financial loss, a substantial profit from continued operations. Indeed, it is no secret that, through the total gains of this campaign, the entire cost of the installation of the Gayley system, including the sum paid for the patent right, was repaid in a few months, though the certified saving of $1 per ton in the average cost of pig iron would not by any means have accomplished that result in so short a time.

The situation above described is one which any manager of a "merchant" blast furnace (*i. e.*, a furnace selling its product to outside

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**Bi-Monthly Bulletin*, No. 24, November, 1908, p. 917.

customers) may at any time encounter. But it carries a meaning also for establishments like the works connected with the United States Steel Corporation and other great concerns, which have a use for the "off iron" produced by their blast furnaces. For such "off iron" could be manufactured at smaller expense than when it is turned out as an unwelcome by-product from a furnace charged and operated, at extra cost, to yield a more valuable product. In short, every blast furnace manager knows that both technical and commercial economy, as well as relief from personal anxiety, would be secured if he could only be sure of making what he is trying to make.

ADDS A FINAL ELEMENT OF CERTAINTY TO BLAST FURNACE CONTROL.

This brings us back to the inquiry: What is the bearing of Mr. Gayley's invention upon this desirable element of certainty, through complete and intelligent control, in the operation of the blast furnace?

As I have already observed, we have sought to secure such certainty through minute analyses of all the raw materials, etc., except the air of the blast, which weighs more than all the rest put together. But when we come to consider this element, we perceive at once that it cannot be usefully analyzed like ore, flux or fuel. We cannot determine its composition and then store it until we wish to use it; and if we could analyze it as it enters our blowing engines our knowledge would come too late to permit any effective action on our part, based upon such information. If we would attain that certainty of control which constitutes the perfection of an art, we cannot treat the air of the blast as we do all the other elements of the charge, which we regard as variables to the character of which we adjust our practice. The air, most variable of all, cannot be thus dealt with. We must make it practically a constant. Mr. Gayley has shown us that the only way to do this is to freeze the moisture out of it. No attempts at vague amelioration by partial measures will meet the case. What we want is, first, to know just what we are putting into the furnace through the blast, and, second, how we can continue to do that particular thing practically without variation.

Mr. Gayley, after years of costly experiment, has shown us for the first time how to attain this object; and I am not surprised that leading ironmasters in this country and abroad have recognized his invention as the greatest advance in blast furnace practice since the introduction of the hot blast by Neilson. It is scarcely too much to say that this invention, completing our mastery of conditions previously uncontrollable, has elevated the manufacture of pig iron from the category of processes which are partly art and partly accident to that of the true arts, which may be practiced with approximate scientific certainty.

HIGH AND LOW AIR PRESSURE FOR SAND BLAST

Mr. James M. Belton has begun in *The Foundry* a valuable series of papers upon "The Sand Blast in the Foundry." From the first instalment we reproduce the following discussion of the relative advantages and disadvantages of high and low pressures.

Most sand blasts are operated under a moderate air pressure, not exceeding 30 pounds, but in some of the later types an air pressure of 80 to 100 pounds is used, principally because that pressure is usually installed for the operating of pneumatic tools, and it does not seem desirable to use a reducing valve and cut down the pressure.

A high air pressure implies the use of a nozzle of small diameter, otherwise the consumption of air would be enormous, and few air plants could meet the demand. The disadvantage of the small nozzle is that it limits very materially the sand that can be used, as only a moderately fine grade will pass through a ¼-inch nozzle, which is generally used with high pressures, without obstructing it, and it is often desirable to use large sand or fine gravel for cleaning. The cost of maintaining the pressure is naturally greater for a given quantity at a high pressure than for low, and although the discharge of the nozzle may not be as much from the larger one under a lower pressure, which will do the same work, the net cost of operation is about the same in either case. The track or cleaning path of the high pressure jet is not as broad as the low pressure and less surface is covered per minute. The sand is badly shattered and pulverized under the high pressure and cannot be used as often as when worked under low pressure. More dust is formed, and an examina-

tion of the casting under a powerful magnifying glass will show that the surface or skin is indented by the particles of sand, and that some particles are imbedded in the casting, giving it a fine coating of silica which is destructive to cutting tools. On this account a low air pressure is required for aluminum, brass, bronze, and other castings of the tin and copper alloys.

It requires 15.94 horsepower to compress 100 cubic feet of air from atmosphere to 80 pounds pressure, with one-stage compression and 6.28 horsepower to compress the same quantity to 20 pounds pressure. A ¼-inch nozzle under 80 pounds pressure will require 85 cubic feet of free air per minute or $0.85 \times 15.94 = 13.55$ horsepower, and if we reduce from 80 pounds to 20 pounds we can use a ⅜-inch nozzle requiring 69 cubic feet of free air, and $0.69 \times 15.94 = 10.99$ horsepower. A ½-inch nozzle, which will give a quicker cleaning, will require, when the pressure is reduced from 80 pounds to 20 pounds, 123 cubic feet of free air per minute, and $1.23 \times 15.94 = 19.60$ horsepower.

There is no special advantage in cleaning with high pressures, and as they limit the range of the sand blast, they are not entirely desirable. If a separate compressor is not available for sand blasting, the pressure may be cut down by means of a good pressure reducing valve, which has the advantage of allowing any change in the pressure as desired, and the disadvantage of requiring the air to be compressed first to a higher pressure than that at which it is used, implying an additional expense for power. Low pressures do as good work, cost less to produce, allow the use of larger nozzles, cover a greater surface in a given time, are easier upon the operator and are less dangerous and generally to be recommended.

DIFFERENT PRESSURES FOR DIFFERENT CASTINGS.

Excellent work can be done in cleaning medium and heavy grade, iron castings under 15 to 20 pounds air pressure; aluminum castings, 10 to 15 pounds, brass, composition or other bronze castings, 15 to 20 pounds, steel castings, 35 to 75 pounds, depending upon whether green or dried sand molds are used and the tenacity of the adhering burnt sand; generally 35 pounds will be sufficient to give a thorough cleaning to steel. For surfacing or frosting finished steel or iron, an air pressure of from 10 to 15 pounds is required and for surfacing brass, bronze and aluminum 5 to 10 pounds, and a fine, white, sharp sand, in grade from No. 40 to No. 100, according to the finish to be obtained.

In considering the question of pressures it should be remembered that the pressures named are those that should be obtained at the sand blast, which can be confirmed by attaching a pressure gage to the sand tank, and that if the air has to be led to any distance from the air compressor and receiver, the delivery pipe should be materially increased to allow for friction, otherwise the pressure will fall off and the action of the sand blast will not be up to requirements. With but little foresight and at a very little additional expense, air delivery pipes of ample diameter can be installed up to the sand blast, giving the benefit of the full pressure as well as that of a considerable body of air behind the sand jets.

MOISTURE IN THE AIR.

The article above quoted then speaks of the trouble which may be caused by moisture in the air, "If the air pipe is long," it says, "condensation may take place within it, which if allowed to enter the sand tank would moisten the sand, and care should be taken to remove this either by trapping or by arranging in the piping a U bend, from the bottom of which any condensed water may be drawn off, and by suitably jacketing the main line."

It is the function of the air receiver to dry the air. If the air in the receiver is at its highest pressure and at its lowest temperature the moisture will be deposited there and no moisture will make its presence known. With the receiver located near the compressor, as is customary, the air is not cool enough, but with a long pipe to traverse, not jacketed, and a receiver near the work the air should always be dry enough.

The Mining World finds that 75 mines and metallurgical works in the United States during 11 months of 1908 paid to stockholders in dividends $44,485,705. The copper companies paid $18,276,092. Forty-six gold, silver and lead mines paid $10,926,936. Six zinc companies paid $2,124,000. Six metallurgical plants paid $12,317,434.

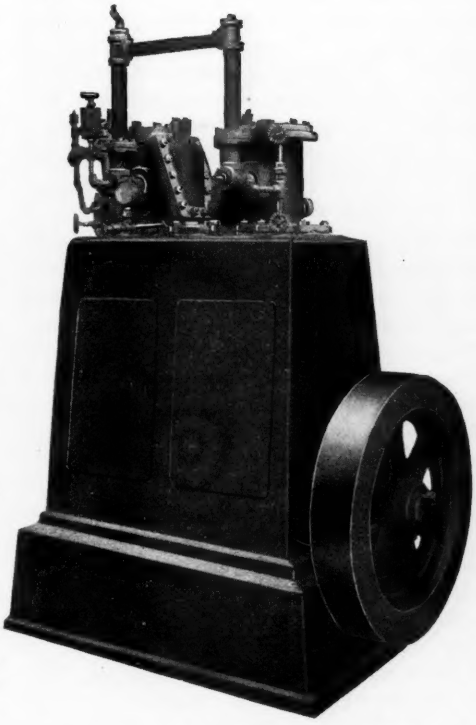
A MONUMENTAL BAROMETER

In celebration of the tercentenary of the birth of Torricelli, the inventor of the barometer, a huge barometer has been constructed in the city of Faenza, Italy. As the liquid used in this barometer is olive oil, the normal height of the column is about 37 feet. It was intended at first to use water, in which case the column would have stood normally at about 32 feet, but this was abandoned on account of the complications which would have resulted from evaporation. Glycerine also was suggested, but the normal height of the column would then have been only 27 feet, which was less than was desired. Olive oil, which was finally determined on, proves to be entirely satisfactory. The tube, which is of iron, except at the top where it is to be observed, is supported by a monumental pillar of stone. The readings are of course affected by temperature, but corrections have been tabulated.

THE WOOD DENSE AIR REFRIGERATING MACHINE

The machine shown in the half tone comprises nothing essentially new in principle, being simply a commercial and convenient adaptation of the dense air, closed cycle refrigerating system so generally employed on Government ships, private yachts and elsewhere. The present apparatus is of a type specially suitable for small units which may be quickly and cheaply installed anywhere, being quite simple and requiring no special skill to operate. The machine may be driven by belt, by electric motor or otherwise as most convenient, and except for this power requirement and the circulating water is entirely independent of everything outside itself.

The responsible elements of the machine are a compressor and an expander cylinder with the necessary operating valves. The same air is used continuously in a closed cycle, the pressure of the return air being maintained considerably above atmosphere. An auxiliary pump makes up for what leakage may occur. The machine requires the connecting of the outgoing and return pipes to the refrigerating rooms. The air compressed is the return air from the refrigerating room. After recompression in the machine cylinder it is passed down to the cooler, which is located in the base of the machine and after being cooled to within a few degrees of the circulating water it is conveyed up again, still under maximum pressure, to the expander cylinder, where it



WOOD DENSE AIR REFRIGERATING MACHINE.

does work in helping to drive the machine and is afterwards discharged into the supply pipe at a reduced pressure and a much lower temperature. The cold air may circulate through a small ice making tank if necessary before going into the circulating coils. The machine as shown is the invention of Mr. Andrew Wood of Bridgeport, Conn., and is put on the market by the Springfield Manufacturing Company, also of Bridgeport.

The explosion of black powder produces 33 volumes of nitrogen; 51 of carbon dioxide; 10.5 of carbon monoxide; 3 of water, and 2.5 of hydrogen sulphide. In a mine where there is an excessive use of powder these poisonous and irrespirable gases soon vitiate the air and render it unfit for breathing.

OPERATING CONDITIONS OF STEAM DRIVEN AIR COMPRESSORS

The following we condense from an article by C. A. Dawley in a recent issue of *Power and the Engineer*.

Compressors for ordinary air pressures of 80 to 100 pounds are built with all combinations of simple or compound (two-stage) air cylinders and simple or compound steam cylinders. The straight line machine has been partially replaced by the duplex type, generally having compound air cylinders and often with compound steam cylinders also.

TWO STAGE AIR CYLINDERS.

In compressing air to 100 pounds gage pressure there is a theoretical saving in compound or two stage compression, as compared with single stage compression, of about 15 per cent. This is based on the indicated horsepower required in the air cylinders to compress and discharge a given volume of free air per minute. This theoretical saving is never all obtained, because in the compound cylinders the air has to pass through two sets of inlet and discharge valves instead of the one set of the single cylinder, and it also passes through an intercooler formed of pipes which circulate water to cool the air between stages. In overcoming the friction due to the valves and intercooler and the extra piping, part of the 15 per cent. saving is lost, but there are other advantages of compound compression which make it at least 15 per cent. more desirable than simple compression, provided it does not make the machine too complicated.

Straight-line machines are often built which have compound air cylinders in tandem, with a simple steam cylinder, and they have sometimes been built with compound steam cylinders also. In the duplex compressors there are two steam cylinders and two air cylinders; the cranks are set at 90 degrees, so that one side helps the other over the centers, and it is evident that with this arrangement both the steam and the air ends may be compounded with no more cylinders and with very little increased complication.

STEAM-VALVE GEARS.

The steam valves used on air compressors are of the plain slide type, the Meyer riding cutoff, and the Corliss. Small straight-line and duplex machines generally have plain slide valves, as this is the simplest and cheapest construction. These valves are always set for a late cutoff for two reasons, first to prevent the machine from stopping in going over the centers at slow speeds, and second to avoid an early opening and closing of the exhaust port.

It is a property of the plain slide valve that an early cutoff can be obtained only by permitting an early release of the exhaust steam and an early closing of the exhaust port, which in turn results in high compression in the steam cylinder. In a mill or generator engine, compression is often desirable to cushion the piston and other moving parts and bring them to a stop gradually at the end of the stroke. This makes the engine run smoothly and quietly and is believed by some authorities to decrease the steam consumption. In a compressor, on the other hand, the air cylinders furnish more than sufficient cushioning, and if in addition the steam cylinders had a high compression, the machine would have to overcome the double pressure, which would increase the load on bearings, rods and frames, besides requiring a heavy flywheel to overcome the resistance.

In Fig. 1 this point is illustrated, as applied to a straight-line machine; *A* is the air card at one end of the cylinder, *B* is the steam card at the opposite end of the steam cylinder, which is at that time driving the air out in the direction of the arrow. Card *B* illustrates usual conditions with cutoff at ¾ or ⅞ of the stroke and with corresponding low initial steam pressure. The card shows late release and practically no compression and very little lead; it would be considered an ordinary good card from a plain slide-valve compressor. The card *C* might be obtained with a plain slide valve designed for early cutoff. If we imagine this card as being at the opposite end of the cylinder from *B* and assume that the pistons have nearly reached the end of their stroke at *D*, it will be seen that the pressure exerted by *B* at position *D* is too little to overcome the air-discharge pressure at *D* on card *A* and the steam-compression pressure on card *C* at *D*. The flywheel would then have to carry the machine over against the heavy compression.

Owing to the late cutoff and resulting late expansion, compressors with plain slide valves make little pretension to economy. They are controlled usually by a throttling governor of

the fly-ball type, which throttles the steam down to a pressure which will maintain the speed constant as long as the air pressure does not exceed the desired limits. There is an air-plunger attachment to the governor, which still further throttles the steam and causes the compressor to slow down when there is not enough air being used to keep the pressure below the point at which the governor is set.

MEYER VALVE GEAR.

For the purpose of overcoming the defects of the plain slide valve in compressor service the Meyer adjustable cutoff is widely employed. This is the same as the plain valve with its late cutoff, but with the addition of two adjustable plates which seat upon ports at each end of the main valve and are adjusted as to lap by right and left screws on a rotatable valve rod. In starting the machine the rod is turned to give the latest cutoff, and when full speed is attained the cutoff is run back to ¼ or ⅜ stroke, which gives the best economy.

The proportion of the steam cylinders to the air cylinders is usually intended to be such that the necessary horsepower may be developed at ¼ cutoff. In a simple machine, either straight-line or duplex, this involves making the diameter of the steam cylinder the same as that of the air cylinder under usual conditions of steam and air pressure. When run at ¾ cutoff, cylinders of this size are, of course, much larger than needed to develop the required power, and consequently the steam has to be throttled down to a low pressure by the governor.

In running at a late cutoff, the steam used per horsepower is increased on account of the incomplete expansion and also by the reduced steam pressure. The action of this on the cards is shown in Fig. 2, illustrating how the steam pressure in the cylinder varies with the cutoff when the air pressure and speed remain the same. Card *A* is for ¼ cutoff, with maximum steam pressure admitted to the cylinder; *B* is for the ⅜, *C* for ½ and *D* for ¾ cutoff. It is a frequent occurrence to have a steam pressure of 150 pounds in a plant where other engines are running, and at the same time have the compressors getting only 50 to 60 pounds in the cylinder. The increase in steam used per hour per horsepower is shown in curve *A* of Fig. 3, which gives the relative steam consumption of a compressor with simple steam cylinders, when producing the same air pressures and at the same speed, but with the cutoff at different points from ¼ to ¾ of the stroke.

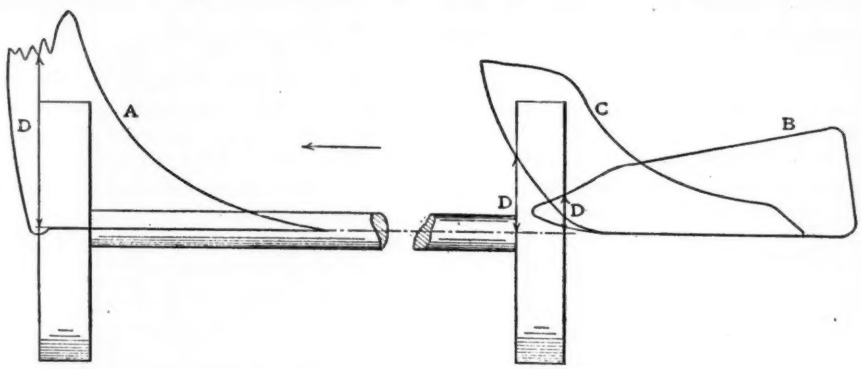


FIG. I.—EFFECTS OF HIGH COMPRESSION.

Here is a detail of compressor management where a careful engineer can save his employer a large percentage of the coal bill, by giving attention to keeping the compressor at its most economical point of operation. The cost of fuel for a machine often equals the total price of a new machine in the course of a year's operation, 10 hours a day, and a saving of 20 to 25 per cent. of this, which is easily obtained by watching the cutoff, is well worth careful attention.

It is not, however, always the fault of the man in charge that he does not run the machine under the best conditions. If the air demand is irregular, so that the speed varies widely, as is often the case, it is found, especially with straight-line machines, that they will stall at slow speeds and not start again

unless run at late cutoff. This requires running out the valve wheel and barring the compressor over to restart, which is no easy trick, and it is only human nature that a man should try to avoid this annoyance by leaving the cutoff at the latest point. The duplex machine will seldom stop at slow speeds, unless the cutoff is earlier than ⅝ or ½ stroke. Another excuse for running at late cutoff is that it produces less strain on the machine, and, if the valves are unbalanced, it makes a decided reduction in the friction and the wear and tear on the valve gear. Whatever may be the merits of the possibility of running at an economical cutoff, the fact remains that probably not over 5 per cent. of the machines in service are so run and never will be until some one brings out a successful and practical machine which does this automatically.

SPEED CONTROL.

The air compressor has one property which is not usual in steam-driven machinery, namely, that the resistance is nearly constant for difference between slow and full speeds amounts to only a few per cent.

The steam cylinders of the compressor will increase slightly in work per stroke as the speed decreases, on account of less resistance to the steam getting through the ports. As the air requires less and the steam cylinder would furnish more work at slow speeds, the result is that the steam is throttled more by the governor, and a lower steam pressure in the cylinder will perform the work, but this lower steam pressure does not decrease the amount of steam required as fast as the condensation of the steam increases it. Cylinder condensation, which consumes 20 to 30 per cent. of the steam used in simple cylinders at full load, may increase to double this amount at low speeds.

In Fig. 4 the curve *A* shows how the water rate increases at slow speeds in a simple compressor cylinder, when the position of the cutoff valve and the air discharge pressure remain the same. The vertical distances on the curve represent percentages based on the best results obtained at full speed.

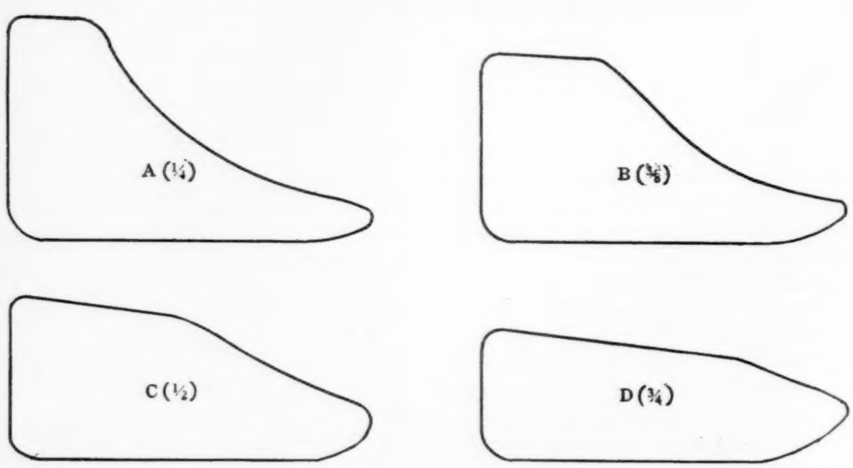


FIG. II.—DIFFERNT POINTS OF CUT-OFF.

the stroke though the machine may be working at a small fraction of its total capacity. This simply means that it takes nearly the same number of foot-pounds to compress a cylinder full of free air, whether the machine runs slow or fast. Actually, the work is a little less at slow speeds, as the air friction and valve losses are less and the intercooling better, but in a machine of good design the

Where there is only one compressor, there is no way to avoid slow speeds at times, but in a plant having a number of machines it is important to keep only enough running to furnish the air required, when working near full speed. Some engineers prefer to use more machines and run slower, saying that they have less trouble with bearings, etc., and that machines last longer if run slow. This is

undoubtedly true, but if a machine is well designed and built, its life will be a certain number of million revolutions, and the sooner these are run off, the sooner the machine will return its value to the owner. Certainly a saving of 10 to 20 per cent. on the steam used per unit of air furnished, is worthy of some effort to keep the plant operating at its highest efficiency. The uniform load above mentioned, in combination with a proper speed, is capable of producing steam economics not exceeded by any class of steam engine.

COMPOUNDING.

This uniform load is also a most favorable condition for compounding the steam cylinders. Many people think of compounding only in connection with condensing and complication, and it is undoubtedly true that in steam engines having an irregular load, the compound non-condensing engine has not much advantage over the simple. But in the air compressor the conditions of load are ideal for compounding, and, moreover, the losses attending late cutoff and slow speed are relatively much less in the compound. In curve *B* of Fig. 3, corresponding to curve *A* for the simple cylinder, it will be noticed that the steam required does not increase as fast at late cutoff as in curve *A*, which is shown by the distance between the two curves being greater at the ¾ mark than at ¼ or ⅜. Also

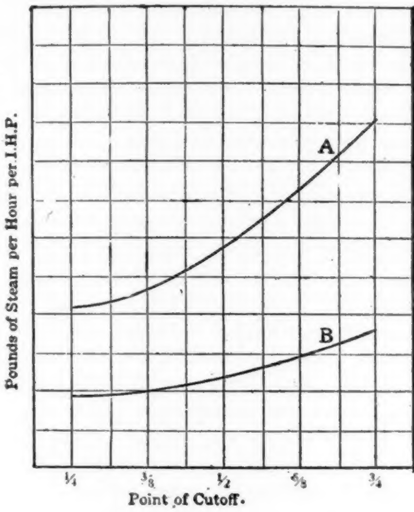


FIG. III.—STEAM CONSUMPTION.

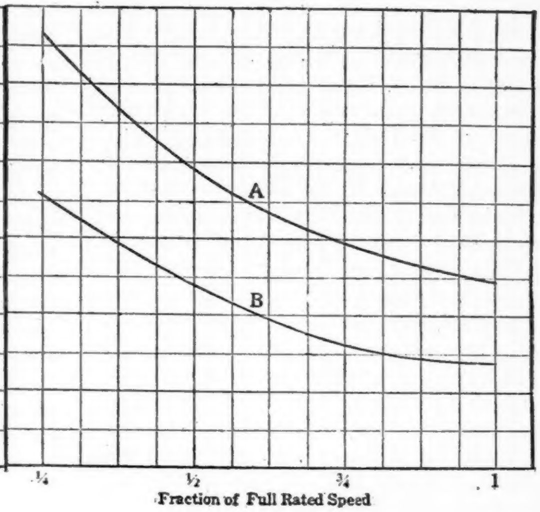


FIG. IV.—WATER RATE.

in curve *B* of Fig. 4 it is seen that the speed variation does not affect the compound as much as the simple.

The proportioning of the cylinders of a compound is a matter of much complexity, involving the size of air cylinders, air pressure, steam pressure, types of air and steam valves, speed, method of governing, cutoff in steam cylinders and whether to be run condensing or non-condensing. Most of these can be known beforehand, and in a Corliss or automatic cutoff engine it is possible to get the best economy and also divide the work equally between the cylinders. In a Meyer valvegear machine it is, of course, impossible to get the best distribution unless the cylinders are designed for some definite point of cutoff and used as designed. With the high-pressure cutoff valve set at any point, more work can be thrown onto the high-pressure side by making the low-pressure cutoff later, or if the high cylinder is doing too much work, it can be changed by making the low-pressure cutoff earlier and so increasing the receiver pressure which, in turn, puts more back pressure on the high cylinder and at the same time admits a higher pressure to the low. The compressor should be indicated and adjusted occasionally, noting the best points of cutoff and the corresponding steam and receiver pressures, so that the same conditions can be readily obtained when desired. If the machine is run at late cutoff or

if a machine intended for condensing is run noncondensing, there is a chance of very uneven distribution of work and strains in the machine.

THE ANCIENT AND THE MODERN CONTRACTOR*

The contractor did not hold in the earlier reaches of human history the dominant position that is his today on the world's stage. He may have been pre-figured in a crude way in the task-master directing and controlling the human forces, the muscle-power, that gave the world the great wall of China, the hanging gardens of Babylon, the pyramids of Egypt, the Roman highways and aqueducts and the Aztec architecture of the American continent, the brain secrets of which have in some cases been hailed in our day as original discoveries. But that almost pre-historic task-master is, perhaps, best represented in modern times in the superintendent or boss of a piece of municipal improvement work done under municipal auspices and by day labor, with its consequent waste of time and waste of money, which had its similitude in the waste of muscle and energy in the days when the world was young and human life was cheap. The real contractor could not come into his own until steam and electricity had been recognized in all their potency, until the locomotive, the printing press and the telegraph had pointed to the saving of time and strength and to the utilization of natural forces for the conservation of society as its mental vision broadened.

Today the ideal contractor stands for the accomplishment of a task, no matter how difficult, in the quickest time and with the most substantial results justified by the money at his disposal. Whether he devotes himself to a specialty or to general contracting; whether he merely builds bridges or undertakes to establish the grades, lay the rails, span streams and tunnel mountains in creating a railroad, whether he raises one single structure or undertakes to build from the ground up a city, with sewerage, drainage and water systems, to shelter 10,000 persons; whether he agrees to furnish supplies for an army or a navy, to give lighting and heating facilities to a community, to construct an immense dry-dock and to transport it half way round the globe, to remove the debris of a city devastated by fire, flood or earthquake, or to manufacture the thousands of tons of paper called for by the manifold activities of a national government, he must have faith and imagination above all else. He must be able to grasp an infinitude of details and be possessed of a wide range of experience and definite knowledge. Quickness to adapt himself to conditions and to seize the occasion must be his. Faltering for him is failure. Hide-bound, he is limited as to opportunities. Narrow-minded and ignorant, he is a case of false pretense and his days are soon numbered.

Glance over the continents and think of what he is doing. Perhaps I may be permitted to cite a group of allied contracting concerns as typical of contracting generally. Their combined work in North and South America, in Asia, in Europe and in Australia represents an investment of more than $50,000,000 and includes power plants, railways, water-supply systems, harbor works, coal docks, tramways, hotels, office buildings, apartment houses, municipal buildings, warehouses, race-courses, carbarns and electric transmission lines. Their operations are under way at twenty eight places in the United States, thirty places in Great Britain, and in Canada, in the Philippines, in India, China, France, Holland, New Zealand, Brazil, Porto Rico, Mexico, Uruguay and Argentina. In handling material had on the ground or from near-by points, or carried thousands of miles, they employ Mexican peons, British navvies, Hindoos, Indians, bushmen, Filipinos, Chinese, negroes and any of the European stock which has come to be of so much importance in the rough work of American progress.

All that implies a combination of hundreds of energies of various kinds, broad-mindedness, steadfastness, nerve and persistence in the contractors, and more or less involuntary widening of mental activities for thousands of the members of black and brown and yellow races, together with an easing of conditions of life for everybody with a speed and a thoroughness possible only through the control by the contractor of vast forces and immense resources brought into co-operation to a definite end.

*From a paper by Richard H. Edmonds, C. E., at the Asheville meeting of the American Public Works Association.

THE OUTLOOK FOR THE AIRSHIP

The following occurs in the anniversary address of Lord Rayleigh before the Royal Society on Nov. 30th:

"I cannot abstain from including in the achievements of the year the remarkable successes in mechanical flight attained by the brothers Wright, although the interest is rather social and practical than purely scientific. For many years, in fact, ever since I became acquainted with the work of Penaud and Wenham, I have leaned to the opinion that flight was possible as a feat.

"This question is now settled and the tendency may perhaps be to jump too quickly to the conclusion that what can be done as a feat will soon be possible for the purposes of daily life. But the fact is there is a very large gap to be bridged over, and the argument urged by Prof. Newcomb and based on the principle of dynamical similarity, that difficulties must increase with the scale of the machines, goes far to preclude the idea that the regular ocean service will be conducted by flying machines rather than by ships.

"However, as the history of science and invention abundantly proves, it is rash to set limits, and for special purposes, such as exploration, we may expect to see flying machines in use before many years have passed."

SOME AIRSHIP SPECULATIONS

I happened just now to run across an old encyclopedia that I used to study when I was a very small boy. As I looked into it I turned to an article entitled "Flying, Artificial," which seemed to link the present with the past, and to connect some of the experiments of recent date with my own flights from the shed roof with the aid of an umbrella, neither being much more certain of success than the other. As I read the article I became more impressed at the lack of progress that 30 years or more have seen, and still more impressed with the idea that progress in the future will be a matter of machine work more than anything else.

There appear to have been two semi-successful attempts at flying by manpower, one about the latter part of the 17th century consisting of two poles fastened over the shoulders by straps (see Fig. 1), to which were fixed a pair of wings at each end. These wings were flexible so that they yielded on the up-stroke and spread open on the down-stroke. The operator pulled down on them in front with his hands and then pulled down behind by means of straps which were attached to his ankles. We need not be surprised to read, "Besnier was not enabled to rise direct from the ground, but by starting from an elevation he flew across rivers of considerable width, and a pair of wings which he sold to another was used with similar success." The most surprising thing was that the second pair were usable. The proportions which the accompanying cut show are manifestly impossible, as I know from my experience with umbrellas.

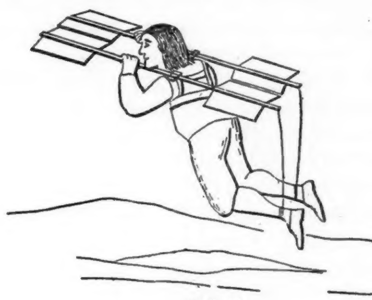


FIG. 1

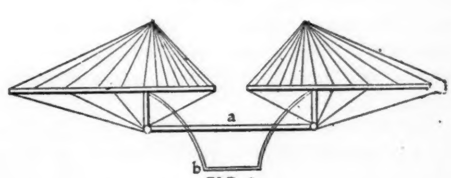


FIG. 2

One hundred and twenty-five years later one Joseph Degen, a prisoner at Vienna, made a pair of wings similar to Fig. 2. He sat on the cross-bar *a* holding himself down on it with both hands, and pushed down on the stirrup *b* with both feet. "With this machine he rose to a height of 50 feet, measured by a cord held by the jailer to prevent his escape. This was done in two minutes' time, but the effort quite exhausted the strength of the adventurous mechanic."

Since then there probably has never been a time when no one was experimenting, or at least planning, some kind of an air ship. The most noticeable difference is in the size of the claims.

AN ENGLISH ATTEMPT.

Probably the most pretentious proposal was in England in 1842 when the House of Commons was asked to incorporate a company to

float an aeroplane to carry letters, goods and passengers. The apparatus was to weigh 3,000 pounds including coal and the plane to have an area of 4,500 square feet. No mention was made of the number of passengers, but assuming the average man to weigh 150 pounds he would have a plane 15 feet square which is not very far from the size of the parachutes used in sensational leaps. Evidently safety depended on getting up high enough so that the aeroplane would have time to develop resistance to falling. This was the first time that it was proposed to run a machine down an inclined plane, until its planes caught it up and enabled it to start through the air. Not a desirable feature if one happened to alight on a deserted farm for extra fuel.

The few attempts at power propulsion which went beyond the paper stage showed that lightness of motive power was the one consideration above all others. In 1868 a steam engine was built with a cylinder 2 inches in diameter, 3-inch stroke running at 600 revolutions per minute on a boiler pressure of 80 pounds per square inch; which, if figured on 40 pounds mean effective pressure, would give a trifle over half a horsepower. The total weight of engine and boiler was 13 pounds. Today an ordinary motor-cycle engine will not weigh over 26 pounds per horsepower with all accessories weighed in.

The first attempts in this country were in the line of dirigibles. Rufus Porter, of New Britain, Conn., built a machine on a small scale in 1833. About 1850 he exhibited a model 22 feet in length, and 4 feet in diameter on almost precisely the lines followed by the air ships used in public exhibitions. It was driven by steam, and indoors only. A full sized vessel 160 feet long proved to be a failure because of the impossibility of keeping the gas from escaping, which sounds as if it might have been clipped from a very recent paper. A certificate of stock in Porter's company has just come to light in the Worcester, Mass., registry of deeds, the text of which follows:

AN OLD STOCK CERTIFICATE OF AN AIR-SHIP COMPANY.

Whereas I, Rufus Porter of the city and county of Washington and District of Columbia have invented an apparatus denominated an aeroport for the purpose of aerial navigation, and have commenced arrangements for constructing two of said aeroports, the first to be 150 feet in length and capable of carrying five persons and the other to be 700 feet long and capable of carrying 150 persons safely at the rate of 90 miles per hour, and whereas George Eaton, of Worcester, county of Worcester and State of Massachusetts, has expressed a desire of obtaining an interest in said aeroports: Now this indenture witnesseth that for and in consideration of the sum of $5 to me in hand paid, the receipt of which is hereby acknowledged, I have assigned and transferred, and do hereby assign and transfer to the said Eaton, one undivided three-hundredth part of said first aeroport that shall be constructed, and also one undivided three-thousandth part of all benefits and emoluments that may arise or accrue from the said large aeroport for twenty years from the time the said aeroport shall have been put in operation. And I herewith covenant with the said assignee that I will proceed forthwith and contract said two aeroports according to my proposition and prospectus published in the *National Intelligencer* of the 19th of March, 1852, and to keep the said large aeroport in repair for 20 years." All of which shows about the same degree of confidence that prevails today. The dirigible balloons of recent years are broadly different in plan or hopes from those of half a century ago. The more recent experiments are yet hardly passing into history. The remarkable thing is that in all this time so little has been learned. It has seemed to be a repetition of failure with little variation in the means used to reach it.—*American Machinist.*

PRECAUTIONS IN USING ELECTRICITY IN MINES

The United States Geological Survey, in a report on the prevention of mine explosions, recommends the following precautions:

"For distribution underground the voltage should not exceed 650 direct current or 500 alternating current, these voltages being intended for transmission to machinery operating at 500 volts direct current and 440 volts alternating current, respectively. Even lower voltages are preferable. The trolley wires should be installed in such manner as to render shocks least likely—that is, placed either high enough to be beyond easy reach or at one side of the track and properly protected.

"Where current at a potential of more than

650 volts is employed for transmission underground, it should be transmitted by means of a completely insulated cable; and where a lead or armored covering is used, such covering should be grounded.

"In all mines having electric installation special precautions should be taken against the setting on fire of coal or timber. Inclosed fuses or cut-outs are recommended, and each branch heading should be so arranged that the current may be cut off when necessary.

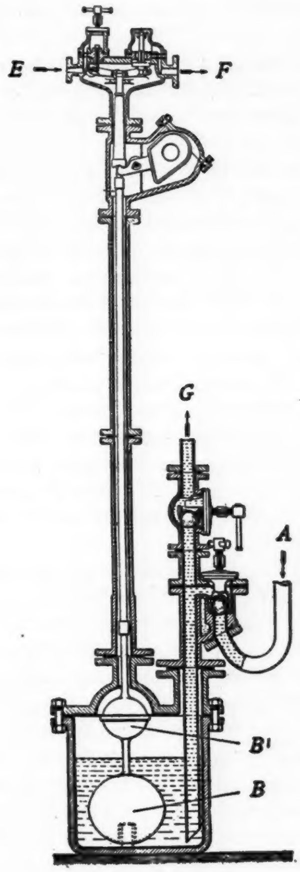
"No live wire should be permitted in that part of any mine in which gas is found to the amount of two per cent.

"In all mines producing gas in dangerous quantities, as indicated by a safety lamp which will detect two per cent. of gas, the working places should be examined by a qualified man using such a lamp immediately before any electric machine is taken or operated there."

For compressed air no precautions are suggested.

THE AUTOMATIC MONTIJUS

The word designating this device comes from the French. It is used in sugar refineries, and especially in chemical works for lifting or transferring liquids, compressed air being employed as the agent and the apparatus being so designed that the corrosive acid or other deleterious liquid shall not come in contact with the operative parts. The cut herewith is reproduced from *Electrochemical and Metallurgical Industry*. In the type here illustrated the liquid has run to the machine by gravity, entering at A through a check valve. Let us assume that the tank is empty and that the full weight of the lower float B keeps the exhaust valve F open, so that the liquid can freely run into the tank. The liquid rapidly covers the lower float B, but the buoyancy thus started is not sufficient to open the air valve E. This is accomplished when the liquid reaches the upper float B[1]. The combined buoyancy of both floats shuts the air exhaust valve F and opens the compressed air inlet E, the liquid being now discharged through the check valve and the discharge pipe G. The level of the liquid drops now rapidly below the float B[1], but the weight thus exerted is not yet sufficient to shut the compressed air inlet valve. This is accomplished after the liquid has dropped below float B, the weight of the floats being now sufficient to shut the air inlet valve and to open the air



relief valve. The conditions are now again the same as at start and the operation is repeated.

COAL DUST AND MINE EXPLOSIONS

Mr. Wm. N. Page, President of the West Virginia Mining Association, in a recent paper presents some rather unusual considerations upon this serious topic.

After a careful study, he says, of the excellent paper of Mr. Haas, read before the Charleston meeting of the West Virginia Mining Association, Oct. 7, the report of Messrs. Desborough, Miesner and Wattagne, to the Secretary of the Interior, and an article written by James Ashworth of Edgcroft, England, and many other similar reports and experimentations, two facts seem to be fairly well established, to which I wish to direct the attention of mine owners and operators as of

vital importance in connection with dust explosions.

(1) Dust, as dust, is not explosive.

(2) It is a physical impossibility to moisten dust to the point of safety, in high velocity currents.

In reference to the first, dust being simply a mechanical division of coal, a chemical alteration must be essential to an explosion, but the division may be so fine as to render the chemical reactions practically instantaneous; and I am satisfied that a mine entry filled with a whirling mass of dust in suspension is a dangerous element, which will augment, or produce, an explosion in contact with the requisite temperature and flame areas. The explosion being due to the gases generated by the rapid flaming of the dust, it follows that the danger lies with this dust in suspension over large areas, and that the dust is harmless when at rest.

In reference to the second point, Mr. Asheworth, quoting freely from Mr. Stokes, H. M. Inspector of Mines for Great Britain, and referring to particular disasters, shows from hygrometric observations, that neither complete saturation of the air currents, nor wet walls, roof and floor, nor all combined, will remedy the danger. Mr. Asheworth says "A practical demonstration of the correctness of these experiments was afforded by the Universal colliery explosion, where the flame of the explosion traversed the whole of the east side districts, although this side of the colliery was naturally wet and the air saturated with moisture; and this proved that the saturation of the roof, floor and sides will not reduce or prevent the extension of an explosion in a mine, as Messrs. Scholz and Stokes appear to have concluded. It has, however, been proved by German experiments that if water is used for the purpose of restricting or preventing explosions, it must be so considerable in quantity that it may be squeezed out of the dust with clenched hand, etc." I think we must all admit that it is a practical impossibility to keep mine dust in such a state.

TOO MUCH AIR THE GREATEST DANGER.

In olden times, when we had to depend on gravity and slow currents for ventilation, no one ever heard of dust as an element in explosions, and even now, I know of no disaster remotely attributable to dust, where high pressure fans were not employed. Until comparatively recently all explosions were attributed to fire damp, and to guard against this danger we have created a new danger in the enormous volume of air traveling at high velocities through restricted channels, which pick up every particle of dust within reach and keep it in suspension. Just as the remedy for fire damp has developed the more serious problem of dust, so will the remedy now universally proposed for dust result in a greater danger from water, because water will not only affect the health of the miner, but it is the indirect cause of every death from roof falls. According to the U. S. Geological reports, 66 per cent. of all underground fatalities is attributable to the fall of roof and coal, and only 34 per cent. to all other causes, and I presume it would be fair to assume that not more than 5 per cent. of deaths can be traced to dust explosions. It would seem therefore, that the remedy of water proposed in the effort to save five lives is now the death portion of 66, and any increase of water in the mine must necessarily add to roof fatalities.

Slate or fire clay probably constitutes over 99 per cent. of the mine roofs in West Virginia, and every practical miner knows that these slates and clays disintegrate rapidly when exposed to atmospheric air and weather on the dumps or spoil banks, and when we force 200,000 or 300,000 cu. ft. of air per minute through the mine at high velocities, we are simply introducing outside conditions underground; consequently the roof constantly disintegrates, crumbles and falls as it would do if the same material was exposed outside; and the more water introduced either by sprinkling or saturation of the air, the more deadly will be the consequences. We had a single-phase danger with fire damp, a two-phase danger with dust, and we will have a three-phase danger with water, more deadly than the other phases combined.

In my humble opinion the proper remedy for dust is not the application of water in any form, as it is not only of doubtful value in relation to the dust, but is unquestionably far more dangerous to life and the mine than all other elements combined.

The only effective remedy is the closing down of the ventilating currents to a velocity at which they will not carry dust in dangerous quantity, and this I believe can be done and

still supply the mine with all the air necessary for the dilution of the gases, respiration and combustion. Any more than a sufficiency for these purposes must be a positive evil through both roof and dust. The tendency heretofore has been to regulate by statutes the specified volumes of air per minute for each man, animal, and light, without any limit beyond the statutory specifications, and the mine inspectors have all considered high velocities as the most desirable attainment, the higher the better, with an eye single to fire damp and pure air for the miner. It seems to me, however, that the time is come when the law-makers and mine experts should study consequences, as too much of any good thing must always be harmful.

Instead of forcing 200,000 cu. ft. of air per minute (or more) through restricted air ways and passages by a single fan, under sufficient pressure to permeate every part of a torturous mine, necessitating high velocities in many passages, I would suggest that the current be split as often as possible, and a number of auxiliary fans be substituted for one powerful single unit. Five fans delivering 40,000 ft. will be preferable to one delivering 200,000 ft., not only because of the slower velocities, but from an actual saving of power through loss of friction. Such small units placed within the mine will operate as force and suction at the same time, and since electricity is now almost universally employed underground, there is no mechanical or other difficulty in the way of installation. The cost of the small units combined will be little (if any) greater than a single unit of equal capacity. Where there is more than one intake and outcast, there is no problem involved, and in shaft mines with limited entrance, the difficulties would be neither great nor costly, as the necessary intake and outcast where the velocities might be high, could be easily isolated from all danger. In other words, the currents could be passed through auxiliary fans and slowed down, just as an electric force can be stepped up or down through a rotary converter. With such arrangement a uniform volume of air, under slow velocity, could be more satisfactorily distributed across all working faces, as a small motor driven fan could be moved from place to place, with little loss of time or money.

I make these suggestions simply to direct the attention of our mine managers to the subject, being fully convinced that water is not an effective remedy for the prevention or restriction of explosions attributable to dust; but granting, for the sake of argument, that it is a preventative, and that dust can be settled by a spray or humidity, its application is too expensive, uncertain, and dangerous, for practical purposes. Death from roof falls is like the falling of leaves one by one, making no disturbance; but an explosion, which kills in groups, though only one-thirteenth as deadly, is like a conflagration which fires the imagination of the public.

In our efforts to protect life and property, we must look to the falling leaves as well as to the burning bush, and the men who die one by one under roof falls, are as much entitled to protection as are those who lose their lives in a spectacular disaster.

SUBMARINE SIGNAL BELLS FOR LIGHTSHIPS

Submarine signals are now stated by many authorities to be the only reliable aid in foggy weather. The system is far beyond the experimental stage and is in successful use both on our own coasts and in some foreign countries. The usefulness of the system is restricted by the fact that it is necessary to install receiving apparatus upon the vessels to be warned. Commander R. F. Lopez, U. S. N., Inspector of the Twelfth Lighthouse District, on the Pacific Coast, writes upon this topic to *Railway and Marine News,* Seattle, Wash.:

On the Atlantic coast, and in foreign countries where the apparatus has been installed, masters of vessels have come to rely implicitly on the submarine bell signals, by means of which they navigate their ships with almost as much certainty in fog as in clear weather. It is now a common thing for the captain of one of the great ocean liners to come on the coast of the United States, get his bearings at Nantucket shoals and proceed to New York Harbor, all by the sounds of the bells coming to him through the water, without being able to see any one of the three lightships, or to hear their aerial fog whistles. Oftentimes in making Cape Flattery in foggy weather masters are unable to pick up Umatilla Lightship, and must haul in and get their position by sounding. This is often dangerous, especially

with a heavy sea running, but with a submarine bell the lightship could be located and the vessel go on about her business.

THE SIGNALING APPARATUS.

The bell is lowered over the side of the lightship; being suspended on a davit, similar to a small boat davit, a chain is attached to the bell, the upper end of which is run over a sheave, thence to a hand windlass which is attached to the davit at the rail. By means of this hand windlass the bell can be raised or lowered. A twin hose, which has two passages, runs from the deckhouse over the sheave and down to the bell to supply air for the bell and the means for striking a code, and also for the exhaust air from the bell to return. This hose is lashed to the chain after passing over the sheave to keep it from slapping against the chain and wearing out. These lashings are roughly six feet apart. The bell is lowered about 25 feet under water, and is rung automatically by means of a code mechanism which is situated in the engine room. This code mechanism is driven by belt from the air compressor (which is a single acting steam air compressor), or in case the lightship does not have steam, this can be a belt driven compressor, driven either by belting it to some shaft such, for instance, as the shaft of an air compressor for the fog horn, or may have its own oil engine with means for driving our air compressor and can, therefore, be adapted to whatever conditions exist on the lightship.

The bell casing is divided into two parts, the lower part being a reservoir into which one of the passages from the hose leads. The air in here is kept at a constant pressure of about 25 lbs. per square inch. The second hose leads to an auxiliary diaphram and air of about 7 lbs. pressure is admitted to this by means of a code ringer. This code ringer has a wheel with dogs spaced for any given code; for instance: Blunts Reef Lightship rings the code of 83 (8 strokes, 3 seconds, 3 strokes, 5½ seconds). This auxiliary diaphragm opens a valve which allows the air from the main reservoir (the bottom half of the casing) to rush under the main diaphragm, bulging the main diaphragm upward. The main diaphragm has connected to it a pull rod for the bell clapper, and each time air is admitted under it and it rises a blow is struck on the bell. The hammer is returned to its position after a stroke, partially by gravity and partially by the aid of a spring which insures its quicker action. The air, after leaving the air compressor and before it enters the bell, is thoroughly dried by passing through a heater and condensing the water out of it.—[This must be a cooler instead of a heater, Ed. C. A.] After it has passed through the bell it is returned to a tank in the engine room and used over and over again. A small inlet valve which works automatically supplies any fresh air that is needed to make up for the losses. It is necessary to dry the air in order that the moisture which is in it will not condense in the bottom of the bell and tend to fill the reservoir. During cold weather these bells should be taken aboard every week or two and any moisture which has collected in the bottom drained out by taking out a small plug prepared for the purpose in the bottom of the reservoir. Although the bell will run even with this reservoir full of water, its action is a little better if the reservoir is kept empty.

RECEIVING APPARATUS.

The receiving apparatus consists of two tanks, which are bolted against the inside skin of the ship about one-half way down the turn of the bow, and as far under the water line as it is possible to get them. No hole is made through the side of the ship, but the open end of the tank which goes against the skin of the ship has a rubber gasket placed around to make it watertight, and the tank is then filled with a solution of fresh water, to which salt is added, making it about the density of sea water. There are suspended two microphones in each of these tanks. These microphones are exact duplicates, and are used as auxiliaries, in case of an accident happening to one the other set can be thrown in. The forward microphone in each tank constitutes the "A" set and the aft microphone in each tank constitutes the "B" set. These microphones are very carefully paired and balanced before leaving the factory, so that the starboard and port microphone of each set are as nearly as possible absolutely the same. The microphone itself consists of a granular button enclosed in the composition case, having a diaphragm on one side, to which the button itself is attached. This is keyed to take the tone of the bell, which is hung over the side of the lightship. It will also pick up other noises; for instance, the propeller of a passing steamer can be heard, but it responds best to the pitch

of the bell, which is used on a lightship. This is 1,215 vibrations a second. The wires from this microphone lead up from a small battery box, from the batteries of which the electric current is supplied, to a box which is called the indicator box. This box has a switch in the middle of its face and the wires are so connected that when this switch is thrown to one side the observer is in communication with the microphone in the port tank, and when the switch is thrown to the other side the observer is in communication with the starboard microphone. There are two small knobs at the bottom. When the one on the left is pulled down a small light is thrown on behind the words, "port" or "starboard," when in use at nightime. The one on the right throws on the auxiliary set of microphones (the "B" set) in case any accident should happen to one of the "A" set of microphones. Two receivers are placed on this box. They are both connected exactly the same, and either one, or both, may be used in making observations. When there is any great amount of foreign noise, such as talking in the wheelhouse, or the noise of the wind in case of a storm, the use of two receivers gives better results.

The bell on the lightship can be picked up with this receiving apparatus ordinarily at from four to eight miles. It has sometimes been heard as high as sixteen or eighteen miles, but these are exceptional. The advantage of the system is that the exact direction of the bell can be obtained on the receiving apparatus by listening first to one side and then to the other. The bell will sound loudest on the side on which it is, and if the exact direction is to be obtained the vessel is swung slowly towards the side on which the bell sounds loudest until the bell sounds equal, when the switch is thrown to starboard and to port.

FOR AIR HARDENING MACHINE TOOLS

Mr. Ethan Viall has sent to the *American Machinist* the sketches here reproduced which originated with Mr. Charles Burgess of the Cyclops Steel Works. Anyone is at liberty to use the devices.

Fig. 1 is a box arranged for cooling tools when air from a fan is used. The box may be made all metal or of wood with a metal top. The slide shown, is for the purpose of shutting

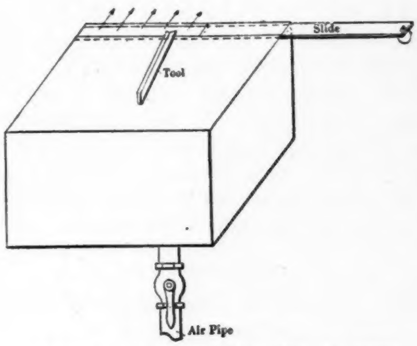


FIG. 1. FAN BLAST BOX FOR AIR COOLING STEEL

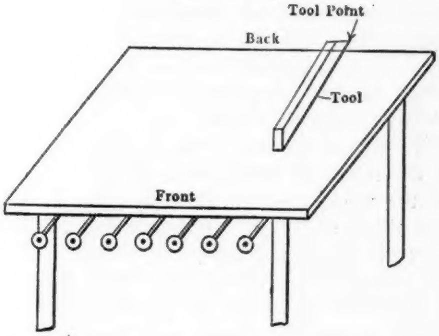


FIG. 2. TABLE FOR USING COMPRESSED AIR

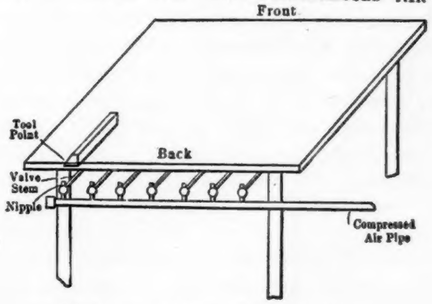


FIG. 3. BACK VIEW OF TABLE

off part of the blast when only a few tools are to be cooled and the arrows show the current of air. In a box arranged in this way the current of air strikes just right, that is a little back of the cutting edge of the tool and passes off at its point. This is the best fan blast cooler for this class of tools that I have seen.

Figs. 2 and 3 are two views of a cooling table for use when compressed air is used. On this table as many tools may be cooled as there are jets. The valves have long stems which extend clear under the plate, and they may be turned on or off from the front.

The plate used may be of boiler iron or a slab of cast iron and anyone can easily fit up the necessary pipes, valves and jets. In some cases it would perhaps be better to use small steam cocks or gas jets and open them from the side they are on, instead of using the long valve stems. This, of course, depends a good deal on the way a man is used to handling his tools and the situation of the table.

THE AEROLITH IN AUSTRIAN MINES

Consul Joseph I. Brittain, of Prague, gives us more detailed information of the "Aerolith" breathing apparatus invented by Engineer Otto Suess and previously mentioned in our columns. The Aerolith uses liquid air, and has been made practicable by recent developments which have so cheapened the liquid air and made it easily obtainable.

The Suess machine consists of a reservoir in the shape of a knapsack, which is carried on the miner's back. This reservoir is filled with liquid air, 3 qts. to 4 qts. being sufficient for two hours. The apparatus is connected by two tubes to a respiratory mask fixed in front of the mouth of the miner, so he may readily inhale the liquid air. The reservoir containing the liquid air has an alarm clock attached to it which warns the miner when the two hours have elapsed. It is claimed that the invention has produced very good results, and at some of the mines laboratories for the manufacture of liquid air are being erected in order that the management may always be prepared.

A LIQUID AIR DREAM

We may be very sure that the possible uses of liquid air are as yet very far from being developed or even thought of. Some of the impossibilities in connection with the utilization of liquid air are, however, quite definitely settled, so that there are many things which those who are sufficiently informed will not attempt to do with it. We therefore in no way endorse the following, which comes from an English automobile publication.

In the writer's view, the advantages of liquid air over petrol are many, among them being absence of combustion, heating, sooting, smell, smoke and noise. Further, the car could be gearless and be able to run for long periods with a tithe of the attention ordinary cars require at present. Its chief disadvantages are two:—The difficulty of keeping it either confined or in a free state, though cars are now in existence having tanks in which liquid air can be safely carried. Liquid air is not a fuel, being merely ordinary air reduced to a liquid state under great pressure, which, when allowed to expand again, exerts enormous pressure. Indeed, it is calculated that if a couple of teaspoonfuls of the liquid are placed in a strong metal cylinder one inch in diameter and six inches in length they will, at the normal temperature of 60 degrees Fahrenheit, exert the tremendous pressure of 12,000 pounds, or about five tons per square inch.

In the experimental cars referred to the liquid is merely allowed to drop into the vacuum container, which is really a copper tube radiator exposed to the air. When vaporized it is taken to a small reciprocating steam engine at about 100 pounds pressure per square inch, but higher pressures are needed to give really efficient results. As regards cost, liquid air can, it is understood, be supplied very cheaply, so that it would seem as if a promising future lies before experimenters in this direction.

FOR TUNNELS UNDER THE DELAWARE

It is now tolerably certain that Philadelphia will soon follow the example of New York by driving tunnels under the Delaware. Gov. Stuart recently signed a charter for the Delaware Tunnel Railroad Company, and almost simultaneously Gov. Fort of New Jersey, signed a charter for the Camden Tunnel Railroad Company, the object of both corporations being to begin immediate work upon the construction of tunnels under the Delaware River between Philadelphia and Camden. According to the plans as they now stand two tubes will be constructed, one fom Second and Chestnut streets and the other from Second and Arch streets, both ending at Third street, Camden. Further, the promoters plan to build an elevated road to the eastern boundary of Camden and to transport passengers from Philadelphia to that limit for five cents. The necessary $15,000,000, it is said, has been assured by prominent financial interests.

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CONTENTS

DEVELOPMENT OF AN ART

The notable article by Dr. Rossiter W. Raymond on the Gayley Air Blast, which we have the pleasure of presenting to our readers in the present issue, is eminently characteristic of its author. It is the strongest and most convincing presentation of the claims of the Gayley invention as such which has yet been made, and it is at the same time highly suggestive upon the general topic of invention and industrial progress and provocative of thought beyond the actual writing.

The value of the improved metallurgical process referred to has been given out to the engineering world as consisting in the reduction of the ultimate cost of the metal produced, but it is here made to appear that far higher claims than this may be made for it. The ancient producer of and worker in metals could get his iron ore and his wood or charcoal together, and with great waste of material and of labor he could bring out the metal in small masses and of uncertain and very different qualities, and from numerous samples he could and did select some which proved to be excellent steel, while other samples graded down through various degrees of worth or of worthlessness.

This uncertainty of result was the characteristic of all the ancient arts, even of the so-called "lost" arts. They were not arts at all, for a true art approximates to not only the highest economy of means and materials but also to certainty of result, and the development and the perfecting of modern industrial arts have been especially in the direction of certainty and of constant reliability of product. Metallurgy becomes more completely an art because of the Gayley Air Blast, for the product of every blast furnace to which it is applied becomes at once more reliable and more closely satisfying the predicated requirements as to quality of product. The actual saving by the Gayley Air Blast is at both ends of the process. Not only is fuel saved and the total output increased, but also the quantity of the product which must be rejected upon inspection is considerably reduced.

This is progress in the right direction, and progress of this character is to be noted in all the arts. Of those with which compressed air is most in touch may be cited the arts of quarrying and tunneling. The old way of getting out stone was to drill holes in the rock almost

haphazard, then to use charges of explosive as big as possible and to select from the chunks thrown out those which could by any possibility be used for any purpose, the majority of the mass going to the dump. Today the stone is cut in the bed precisely to predetermined lines and the stone brought out can generally be guaranteed in every particular before operations are commenced. Tunnel work also is conducted with precision resembling that of the modern quarry, and this is true mechanic art.

TWO SEVERE MINE EXPLOSIONS

The record of the year just closed contains an alarming number of disastrous mine explosions, and two of the most severe of these occurred near the end of the year, one near the beginning and the other near the end of the month of November, the former in Germany and the latter in the United States.

In the first of these 380 miners were cut off at the Radbod mine, three miles from Hamm, Westphalia, by explosion and fire, and 339 perished. Only six managed to escape when the blast came and thirty-five were rescued severely injured. The disaster, which was the greatest of its kind Germany has had in many years, occurred at 4 o'clock in the morning. A tremendous explosion, shaking the whole countryside, was heard, and dense smoke began to pour from the shafts. Rescuers encountered obstacles which for a long time barred their way. The force of the blast damaged one of the shafts, which had to be repaired, and the flames and smoke made it impossible for any human being to enter and live. A special body of men who had gained fame by heroic work in the Courieres, France, disaster, in March, 1906, were among the rescuers, but even these were forced to wait for hours until the firemen had sufficiently subdued the flames to permit any attempt at rescue. The fire began to gain on the firemen, all the relief parties were called out and the workings were finally flooded to extinguish the fire.

On Saturday morning, Nov. 28, 1908, an explosion occurred at the Rachel shaft of the new mines of the Pittsburg-Buffalo Company, at Marianna, Pa., by which 138 men lost their lives. This mine, not yet quite completed, only main entries having been cut and progress made in tunneling to connect with another shaft half a mile away, was one of a group being opened by the Pittsburg-Buffalo Company, with the advice of the most expert mining engineers in the world. Every contingency had been taken into consideration and all means were provided to insure the safety of the men who were from the beginning and who would ultimately be employed in the mine. This mine was thoroughly explored by the foreign experts who recently visited this country under the auspices of the United States Geological Survey, and was by each of them pronounced one of the most admirable in its engineering and lavish in its equipment they had ever seen.

The shaft at or near which the explosion occurred is 488 feet deep. State Mine Inspector Louthitt had just emerged from the shaft having found everything in perfect order. The cage had just been started on the downward trip again when the explosion came. The cage was driven out of the shaft and to the top of the head house, falling back on its side, the three men who were in it being killed. A mine foreman, who was in the cage, was picked up dead several hundred feet away. The explosion was at 4 o'clock Saturday morning and the first rescue party got down at 2 o'clock in the afternoon, bringing out only one man alive.

No official statement has at this writing been made as to the cause of the disaster. At least three theories have been advanced.

1. Explosion of dust which might have been ignited by an electric spark from a mining machine or by a shot fired.

2. Marsh gas or fire damp ignited by either of the above causes or by an open lamp.

3. Presence of natural gas which at times had been found in the mine and which came from all over the adjacent territory.

James E. Roderick, chief of the Department of Mines of Pennsylvania, said:

From the reports I have received I believe the accident was due to a blown-out shot; that is, an overcharged hole in which the powder had flashed out, setting fire to the coal dust in the mine. No devices have been invented which will prevent such an accident as this, if, as I believe, it was due to a blown-out shot.

An old oil and gas well driller of the region says that he has often when drilling wells found pockets of natural gas in the coal measures of sufficient volume to set fire to his rigs, and has himself been seriously burned therefrom. It is his idea that such a pocket was

tapped by the workers in the mine, and that it came in such volume as to fill the entries, so that it would have been impossible for the men to have escaped from it before the explosion took place.

THE UPS AND DOWNS OF THE YANKEE

The U. S. cruiser Yankee, stranded on Spindle Rock, Buzzards Bay, Mass., late in September, was floated and pulled from the rocks on Dec. 4 and sank twelve hours later in Buzzard's Bay near Penikese Island. She is in comparatively shallow water, resting on even keel and it is expected that there will be little difficulty in raising her, so that we may hope in a succeeding issue, to tell the story all at once. After the failure of attempts made by the Government engineers to raise her a contract was awarded to John G. Arbuckle of Brooklyn to do the job by the aid of compressed air. The attempt to raise her succeeded, but while she was being towed to New Bedford to be dry-docked, the services of the air compressors being still required to keep her afloat, the hawsers parted and she was struck in the side by one of the tugs. The compartment penetrated was where the compressors were working, and when they stopped down she went again.

A COAL MINE THEATRE

For educational and experimental purposes, and entirely without advertising intent, the United States Geological Survey is about to establish at Pittsburgh a novel exhibition. It will be in the top story of a large building, occupying the entire floor, which will be divided by a glass partition, on one side will be accommodations for spectators and on the other side an interior of a coal mine will be reproduced as realistically as possible.

Coal operators in various parts of the country will be invited to send intelligent men, who are practical miners, to watch the performances at the theatre, and to take part in them when they choose to do so. The room on the stage side of the air-proof glass partition will be filled, for one experiment, with firedamp. Then men will go into it with patent helmets on their heads and oxygen apparatus strapped on their backs, and will show how long it is possible, with such aids, to remain safely in the poisoned atmosphere.

There will be a sort of walking track, of so many laps to the mile, around which the miner, wearing helmet and oxygen machine, will perambulate—the idea being to find out how much bodily effort he is capable of under such conditions. In order to vary the tests as much as possible, men will be required to do a variety of difficult stunts, such as walking up a high ladder, crawling through a long, dark passage, and coming down another ladder, just as they might be obliged to do in a real mine—repeating the performance, perhaps, with a dummy man carried in the arms.

It is altogether likely that some of the men subjected to these tests will succumb—in which case an emergency door in the glass partition will be instantly opened, and the victim of gas poisoning will be pulled out and revived. The expectation is that in this manner an accurate measurement will be obtained of the amount of work a man engaged in an effort of rescue in a mine can be expected to do, and of the length of time during which it would be safe for him to remain within the precincts invaded by poisonous gases.

The miners, who, as observers of or participants in the performances in question, derive practical information therefrom, are expected to become in their turn instructors.

CALCIUM CHLORIDE AS A PREVENTIVE OF FREEZING IN AUTOMATIC SPRINKLER SYSTEMS.*

In the protection of factories against fire by the automatic sprinkler system, a herring-bone system of small water pipes is spread over the ceiling with fusible sprinkler heads distributed so that each head protects an area of about 100 square feet of ceiling above and floor below. These heads are usually designed to melt at a temperature of about 150 degrees F. so that any fire starting beneath them and causing them to attain that temperature is automatically quenched by a jet of water released from the pipes through the melted sprinkler head.

In cold buildings these water pipes are apt to freeze; to prevent which, it has been customary to fill the pipes with compressed air, an air valve being placed in the main water-supply pipe just below the freezing line. The air valve may be underground or in a room sufficiently warm at all times to prevent the freezing of the water pipe just below the valve. This air valve, which is really a check valve

*Rutger B. Green in *Cornell Civil Engineer.*

against the air and separates the air-filled part of the piping from the water-filled part, has to be designed with a large air-area opposed to a small water-area so that it is necessary to furnish an air pressure of only one-quarter or one-third the water pressure; the idea is that when a sprinkler head is melted by fire under an air-filled system, the more air there is in the pipe, the longer it takes the water to push it along and reach the fire, a few seconds' times often being of great importance in what is called a quick fire. To this objectionable delay in the use of compressed air there has been added the high first cost of the air-valve, the care needed to keep it in good order, its taking up three or four times as much room as the watermain, and the fact that compressed air is not always available at isolated buildings. Again, an air leak in a piping system is very difficult to find so that electrical alarms and constant watchfulness of the air valve are needed to prevent the air leaking out and water following it up in cold weather, when a freeze-up would be very expensive in itself as well as dangerous in case of a fire at the same time.

The mills in which the writer has had charge of the fire protection make carbonate of soda from salt and limestone, the sodium chloride and calcium carbonate being broken up and reunited into sodium carbonate and calcium chloride, the latter being regarded as a by-product. In solution, calcium chloride is much heavier than water, slow to boil and slow to freeze, strong solutions being able to withstand temperatures as low as 30 degrees below zero. Its general introduction as a non-freezing solution for the water-jackets of automobiles some years ago suggested its use as a substitute for compressed air in exposed automatic sprinkler systems. The insurance companies, when asked for approval of this innovation, raised the question of expansion. The coefficient of calcium chloride is high, so that as the check valve prevents the expansion's finding relief back in the water main, it might send the pressure on the sprinkler system up to bursting point and cause as much damage by water as a fire would. Various arrangements were suggested to take care of this expansion, the most prominent being air-chambers, relief valves, and a U-seal arrangement of the supply main to take the place of the check valve in preventing the heavy calcium chloride from working back into the main. Recent experience in rail welding having shown that the expansion in the rails of street railway tracks has a way of taking care of itself when the rails are laid too close to allow of longitudinal expansion, an experiment was tried with two sprinkler systems, one building being equipped with an expansion air-chamber, and another unimportant building without any expansion device at all. The elaborate air valves were then replaced with simple check valves, and a strong solution of calcium chloride was pumped in. A year's test showed that the expansion took care of itself as in the railroad rails. Evidently a network of small piping has considerable elasticity, which is helped by the trapping of small quantities of air in the piping when being filled with the calcium chloride, and by small leakages back through the check valves, very few of which will not leak a little.

In filling a sprinkler system with calcium chloride on the approach of cold weather, it is first necessary to drain all the fresh water out from above the check valve, as the calcium chloride is so much heavier than water that any water remaining in the pipe will be floated up into the small piping under the higher roofs, where it may freeze before it has had time to combine with the calcium chloride solution. This drainage is done through the customary drip-pipes provided in the air system, where it is even more important to get all the water out of a system before pumping in the air. Again, in very cold buildings, care must be taken to let the air out of the high points of the piping system as the calcium chloride is pumped in. Otherwise, any large quantity of air trapped in the pipes will leak out so slowly as to be unsuspected and thus make room for fresh water to enter through the check valve and possibly for the calcium chloride to pass out. The air is very readily let out through vent cocks or by unscrewing an occasional sprinkler head itself. This precaution is rendered less important from the fact that the check valve is usually placed in the large supply main, which is less liable to freeze than a small pipe, and also has so much calcium chloride in it that fresh water getting through the check valve is taken up in the solution before it can freeze.

This substitute for compressed air has been used for four winters successfully in unheated warehouses in Detroit.

U. S. SEAGOING DREDGES

At the recent annual meeting of the Society of Naval Architests and Marine Engineers Mr. Thomas M. Cornbrooks presented a paper on the seagoing suction dredges built and building for the United States Government. These range in length from 166 to 300 ft., and capacities of bins from 1,000 to 3,000 cu. yd. The latest dredge is the Galveston, which has just been completed at the works of the Maryland Steel Company, Sparrows Point, Md. In operating it, it is kept moving forward, at a speed of six knots per hour, with the suction pumps dragging on the bottom. The material is sucked up by 20-in. centrifugal pumps and discharged through pipes and distributing chutes into the bins. By gates in the bottom and sides of these chutes it is possible to distribute the material evenly. As the bin fills the water is drained off by overflows through the sides. When the bins are full the dredge goes to its dumping ground and the load is discharged by opening the gates in the bottom, which are operated by a double cylinder vertical engine through worms and fixed nut on vertical rods. The dredge is propelled by two compound engines, steam for which is furnished by four single-ended boilers.

COOLING INTAKE AIR

It is possible that one reason why pre-cooling of the supply to air compressors is so seldom done is the dread of the "practical" man in charge that the air may be moistened. Of course, moisture in the air is one of the chief troubles with which users of compressed air have to contend; but by proper arrangement of the cooling apparatus, it should be possible to draw the air into the compressor not only cooler, but dryer than ordinary air. It will be remembered that the capacity of air to hold moisture rapidly falls off as its temperature is reduced. By subjecting the entering air to direct contact with cool water, the moisture will be condensed and caught by the water.—*Exchange.*

Take the air into the compressor as cool as possible, is a rule without any exception that we can think of. It is hardly worth while to consider the moisture that may be in the air when it enters the compressor cylinder. It will make no trouble then. After the air is compressed to the usual working pressure of say 6 or 7 atmospheres, 75 to 90 pounds gage, and is cooled to normal temperature while at that pressure, it is, in our climate, almost sure to be more than saturated with moisture, and if it is given a chance to drop the moisture then there is not likely to be any trouble with the moisture in the air after that. Cooling the intake air is a direct saving of power by reducing the volume to be compressed.

WESTINGHOUSE.

The Westinghouse Electric & Manufacturing Company has again become the property of the stockholders, after having been in the hands of receivers since the 23d of October, 1907. During the year the receivers have been in charge they have not only succeeded in paying off the interest on bonds, as it fell due from time to time, but they have also kept the large factories of the company in operation during the entire time, doing an excellent business at a net profit of over $1,000,000. The action of 5,000 employes in subscribing for $600,000 of stock of the company was a feature presented to the court, which made a great impression, because it demonstrated the amount of confidence the employes themselves had in the company. It was also brought out that the company under the reorganization would in every way be in a better condition than at any previous period in its history, as it would start upon the new regime with cash on hand amounting to upwards of $15,000,000, with an indebtedness of only about $200,000. Mr. Cravath in addressing the court on behalf of the Stockholders' Committee, stated that in the annals of receiverships, this one stood without a parallel as the most successful.

TRADE PUBLICATIONS

Applications of Thermit in Foundry Practice, Goldschmidt Thermit Company, New York, 28 pages 6 by 9 inches. The value of Thermit in foundry work consists in the fact that the high heat of 5,400 degrees F. can be applied anywhere and without apparatus to increase the temperature of iron and steel and facilitate the introduction of other refractory metals. This pamphlet gives interesting and valuable information concerning the application of Thermit in the lines indicated.

Deviation in diamond drilling has been known to be as much as 2185 feet in a depth of 4802 feet.

NOTES

White oak timber in mines will last on the average three years in return air and four years in intake air.

The wholesale trade value of the candy produced in the United States this year will equal $100,000,000, and the cost to the actual consumers will be 30 to 50 millions of dollars more than this.

The latest issue of Mine and Quarry, the quarterly publication of the Sullivan Machinery Company, is an attractive and unusually interesting number. Its *piece de resistance* is a description of the power plant of a large coal mine in Pennsylvania.

The Westinghouse Diary for 1909, its fifth year of publication, is a neat and complete pocketbook, comprising, besides the complete diary, a variety of general data and also more than ever of information concerning the Westinghouse products. Every engineer should want it, and can have it.

Acetylene is being used in Germany as an explosive for blasting purposes. Each cartridge contains slightly less than 2 oz. of calcium carbide. After wetting the carbide the confined mixture of generated gas and air is exploded by an electric spark. Rock, when blasted in this way, is not thrown out, but is broken up into pieces small enough to be readily removed.

The C. & G. Cooper Company, Mt. Vernon, Ohio, is installing two tandem compound steam engines of 3,000 hp. each in the plant of the American Steel & Wire Company at Braddock, Pa., and is also installing two 4,000 hp. and one 2,500 hp. tandem compound engines in the rail mill of the Edgar Thomson Works of the Carnegie Steel Company at Bessemer, Pa.

The United Iron Works, Spokane, Washington, have succeeded the Bradley Engineering Company as agents for the Sullivan Machinery Company. They also represent the Sullivan Machinery Company at Seattle. Mr. Austin Y. Hoy is the personal representative of the Sullivan Company, with headquarters at Spokane.

At the Spokane fair rock drilling contest two miners of the Butte camp broke all records in hand drilling by drilling 56⅝ inches into solid granite in 15 minutes. Five years ago a record of 55 inches was made. The miners displayed wonderful skill in changing drills, the changes being made without the loss of a single stroke.

A demonstration of the Menne oxygen torch for opening tuyeres took place at Pottstown, Pa., recently at the works of the Warwick Iron & Steel Company. It happened that one of the tuyeres was closed. It was quickly restored. The method has also been shown at the plant of the Lackawanna Steel Company at Buffalo. Since oxygen is now being made on a commercial scale in this country the Menne process is likely to be widely adopted.

An ozone plant for purifying the water supply has been installed at Lindsay, Ontario. The water comes in part from swamps and also is exposed to sewage pollution. It passes through a roughing filter containing 3 ft. of coarse sand before entering the ozonizing tower, which is about 30 ft. high. Here it passes down a number of vertical 4-in. tile pipe into which the ozonized air is delivered by brass pipes.

The United States Steel Corporation is to establish a bureau of its own for scientific research. It is to have a special building with complete and independent equipment at the Duquesne works near Pittsburg. The first head of the bureau will be John S. Unger, now assistant general manager of the Homestead works. While research has been carried on by the various constituent companies the object is to make investigation more systematic and thorough for the benefit of the entire organization.

It has been found impossible until quite recently to remove the last traces of impurities, especially sulphur and phosphorous, from iron and to produce it chemically pure. A German chemist, Dr. H. Kreusler, by a long series of ingenious processes, partly chemical and partly electrical, has at last succeeded in isolating the pure metal, the properties of which differ

greatly from those of the familiar, impure metal. Iron prepared by Kreusler's process resembles platinum, and perhaps costs nearly as much.

At the Lance Colliery of the Lehigh and Wilkesbarre Coal Company at Plymouth, Pa., recently the throttle of the hoisting engine stuck while hoisting a miner in the cage. Finding he could not stop the engine the engineer reversed when the cage was near the top and again when near the bottom, so that the occupant was shot up and down at full speed over and over again. The engineer kept blowing the whistle and finally other employes succeeded in shutting off the steam, with both the engineer and the miner near total collapse.

About three years ago Mine No. 4 of the Berwind-White Coal Mining Company, at Valier, Pa., filled with water during a temporary suspension of operation. Two large pumps were installed last May, and kept in continuous operation until about the middle of October, the capacity of the pumps being respectively 200 and 587 gallons per minute. They reduced the water at the rate of 1,133,-280 gallons per day, the total number of gallons of water taken from the mine from May to October 15 being 186,981,200, and the mine is again ready for operation.

The most congested street crossing in New York is at 42nd Street and Fifth Avenue, the traffic being enormous upon both thoroughfares and practically continuous for at least twelve hours of the day. As a means of relief it is now proposed to have a depression in 42nd Street thirty-two feet wide with thirty-six feet at Fifth Avenue. In this depression the surface cars and heavy vehicles will be operated. At the side of the street on the usual grade light vehicles will cross. Fifth Avenue will intersect by a viaduct over the depression, and a bridge of ornamental construction will be built.

There died in Glasgow recently Thomas Wilson, mechanical engineer of the Caledonian Railway Company on the Forth and Clyde Canal, whose grandfather, bearing the same name, and then a carpenter-mechanic in the employ of the Forth and Clyde Canal Company constructed for that company the first iron vessel in regular service in Scotland. This was the Vulcan, launched May 14, 1819. She was 61 ft. long, 11 ft. beam, and 4 ft. 6 in. deep, and was built of plates and flat bar frames, the framing and stanchions being forged wholly on the anvil by hand labor. The Vulcan commenced plying on the canal in 1819 and was in service as recently as somewhere in the seventies.

The introduction of vanadium renders steel very mild when annealed, and very hard when tempered. Armor plates can be produced of vanadium steel with an extremely hard outer surface and with a soft backing. The superior ductility of the soft backing of vanadium steel would avert the splintering of hardened plates and shields when struck by projectiles. The point of greatest importance in connection with the use of vanadium steel on armored vessels is, that it will be possible either to reduce the present thickness and weight of plates while preserving the same protective power, or to increase the protection by at least 90 per cent. by retaining the same weight and thickness.

Definite plans and proposals are being considered for a system of electric and pneumatic despatch tubes for the distribution of freight in New York City. The project as urged by Representative Charles N. Fowler, of New Jersey, is similar to one recently proposed by the Amsterdam Corporation except that the cars are much smaller, and the system contemplates not only the transportation of freight from the railroads in New Jersey to New York warehouses, but delivery also to retail stores and parcels to apartment houses and hotels. It is urged for the system that it would save the city annually $5,000,000 in paving and street repairs, $3,000,000 in the removal of waste and would practically do away with horses for heavy trucking.

Six men lost their lives by suffocation in a salt mine shaft near Detroit on Nov. 28. A contracting company has been engaged in sinking a shaft to be 880 feet deep for the Detroit Salt Company. The six men were at work excavating 500 feet down in the shaft. Their

supply of air came from a two-foot canvas tube, which ran down the shaft from the surface of the ground. In some unexplained manner this tube became either tangled or clogged about 200 feet down from the surface. With the air supply shut off, the shaft rapidly filled with gas, hydrogen sulphide, and the men were suffocated. It was some time before the rescuers from the surface could reach them, and then they were at first able to extricate only four of the bodies.

The North Dakota, our biggest battleship, lately launched, is 510 feet long or 60 feet longer than the Connecticut. Her displacement is 20,000 tons which is 1,000 tons in excess of the largest vessels of the British Dreadnought type. The most striking feature of this battleship is the "spider" masts, so constructed as to be hard to cut down with shots, and thus making it possible to keep lookouts up in the air at critical moments. The North Dakota is called more massive in armament, swifter in speed and stronger than the best of the British monsters, the apparent fate of all being to rust into uselessness or to be superseded by still more formidable craft. When we last figured up the cost of a warship it came to 25 cents a pound, Corliss engines at the same time costing 3 cents or less.

Carbide when pure will yield from 5.5 to 5.8 cubic feet per pound. Between 4.25 and 4.75 cubic feet is the average yield from the commercial product. The relative quantities, by weight, of water and carbide necessary to form acetylene and dry slaked lime are 36 parts of water and 64 parts of carbide, which yield 26 parts of acetylene and 74 parts of slaked lime. Water will, therefore, theoretically decompose nearly twice its weight of carbide, but in practice, in a good generator, about 17 times this quantity is used. The reason for this is that the decomposition of carbide and water into acetylene and lime liberates heat. The quantity liberated from good carbide is 730.73 B.T.U. per pound of carbide. One pound of carbide will raise the temperature of 8⅓ lb. (one gallon) of water about 87 degrees F.

The members of the trades unions employed in the shipbuilding plant of Furness, Withy & Co., Hartlepool, England, voted November 4, at the rate of 10 to 1, to give a year's trial to Sir Christopher Furness' profit-sharing proposition. The thousands of employees in the Hartlepool plant will buy stock in the concern immediately, on which they will receive a 4 per cent. dividend, whether the company has a surplus at the end of the year or not. The stock will be paid for by a 5 per cent. deduction from wages, until the indebtedness is cleared. The venture is said to be the largest profit-sharing scheme ever attempted. In the agreement between Sir Christopher and the unions a pledge by the men against future strikes is exacted. All disputes and differences will be left to a work's council, composed of an equal number of officials and workmen.

LATEST U. S. PATENTS

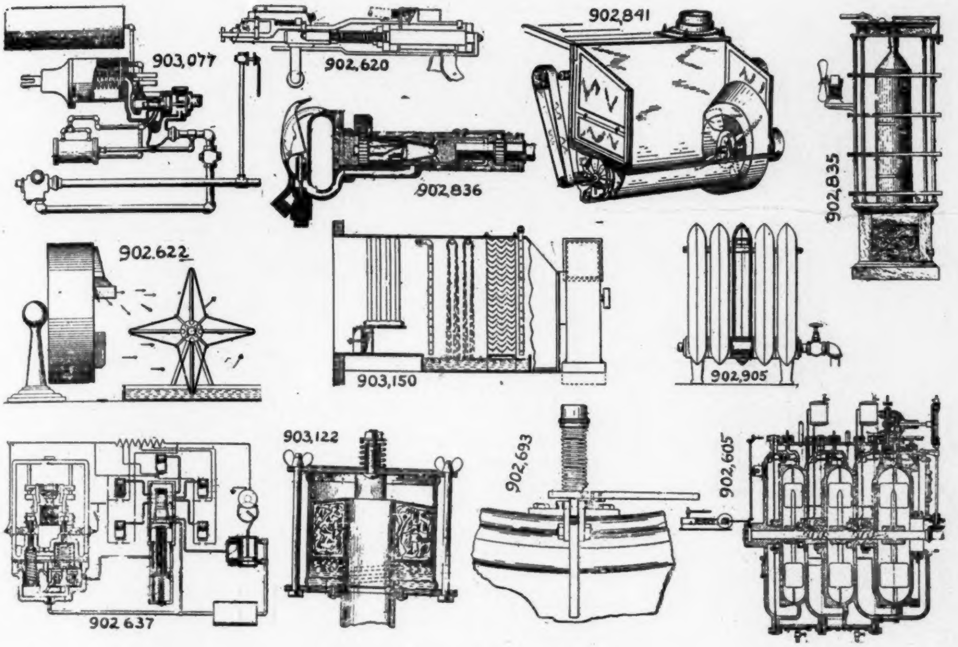
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 3.

902,605. APPARATUS FOR CENTRIFUGAL FLUID COMPRESSION. SIDNEY A. REEVE, Worcester, Mass.
902,620. PNEUMATIC NAIL DRIVER. SCOTT B. STEWART, Augusta, Me.
902,622. HUMIDIFIER. CHARLES SUBERT, Chicago, Ill.
902,637. FLUID-PRESSURE SYSTEM. BERT AIKMAN, Chicago, Ill.
902,693. INDICATING DEVICE FOR USE WITH PNEUMATIC TIRES. THOMAS SLOPER and ROBERT SLOPER, Devizes, England.
902,835. AIR MOISTENER AND EVAPORATOR. OSCAR R. RICE, New York, N. Y.
902,836. FLUID - PRESSURE - OPERATED DRILL. ANDREW F. ROSS, Long Island, N. Y.
902,841. PNEUMATIC STACKER. JOSEPH K. SHARPE, Jr., Indianapolis, Ind.
902,842. FAN FOR PNEUMATIC STACKERS. JOSEPH K. SHARPE, Jr., Indianapolis, Ind.
902,905. HUMIDIFIER FOR RADIATORS. GEORGE J. PALMER, West Chester, Pa.
903,077. AIR-BRAKE. WILLIAM P. GENTLEMAN, Beatrice, Nebr.
903,122. AIR-PURIFYING DEVICE FOR AUTOMOBILES. HERMAN E. WHIT|&7, Palmyra, N. Y.
903,150. METHOD FOR PURIFYING AND HUMIDIFYING AIR. WILLIAM *G. R.* BRAEMER, Buffalo, N. Y.

NOVEMBER 10.

903,264. FLUID-ACTUATED ENGINE. EDWIN J. ARMSTRONG, Erie, Pa.
903,298. PNEUMATIC BUTTER-SEPARATOR. LA FYETTE LILLARD, Bootjack, Cal.
903,325. REDUCING-VALVE FOR COMPRESSED - FLUID MOTORS. EUGENE SCHNEIDER, Le Creusot, France.
903,379. AIR-BRAKE. WILLIAM R. HEIRONIMUS, Evansville, Ill. ﬃ ﬃ ﬃ ﬃ ﬃ ﬃ
903,405. MEANS FOR PREVENTING DOUBLE EXPOSURES. PERCY F. RICE, Tustin, Cal.
903,420. HYDRAULIC COMPRESSOR. LOUIS E. L. THEMKE, Strathcona, and SAMUEL MCCARDIA, Edmonton, Alberta, Canada.
903,543. AIR-PUMP. ALPHONSO S. COMSTOCK, Evanston, Ill.



PNEUMATIC PATENTS, NOVEMBER 3.

903,646. AIR-INJECTOR. ERICH WERWATH, Linden, near Hanover, Germany. ffl ffl

03,660. AIR-PRESSURE SYSTEM FOR TURRETS AND THE LIKE. HERMAN BENSCH, New York, N. Y.

NOVEMBER 17.

903,892. FLUID-PRESSURE SYSTEM. WILLIAM F. SCHNEIDER, Norwood, Ohio, assignor to Allis-Chalmers. ffl ffl ffl ffl ffiffl

903,921. DUMPING-CAR. MUNSON H. TREADWELL, New York, N. Y., and CARL P. ASTROM, East Orange, N. J.

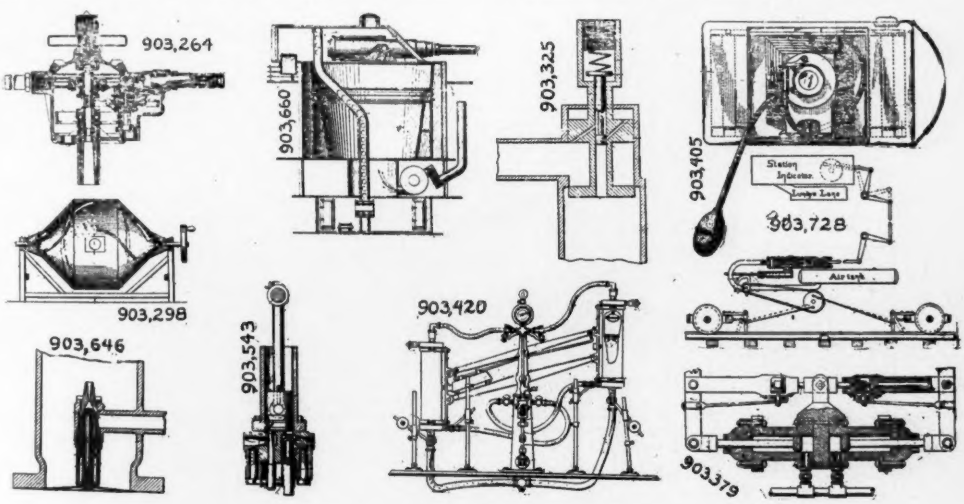
904,219. AIR-COMPRESSOR, &c. ISAAC PATRICK, New York, N. Y.

904,294. AIR COMPRESSOR. HARR E. BAILEY, Albany, N. Y.

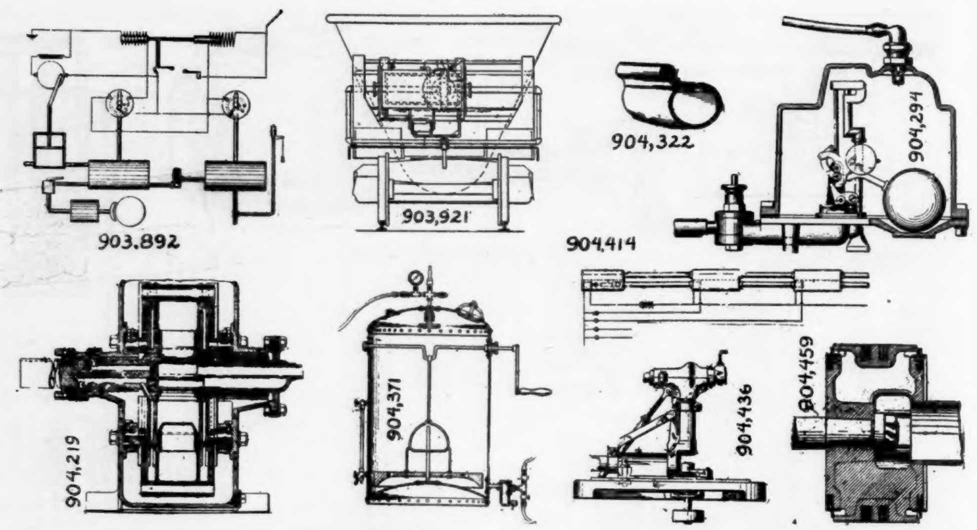
904,322. PNEUMATIC HORSE-COLLAR. ALEXANDER J. FIKE and CHARLES M. FIKE, Clifton Mills, W. Va.

904,371.. SPRAYING DEVICE. JOHN W. STEWART, Martinsburg, W. Va.

904,414. PNEUMATIC - CARRIER SYSTEM. WILLIAM H. EARL, New Orleans, La.



PNEUMATIC PATENTS, NOVEMBER 10.

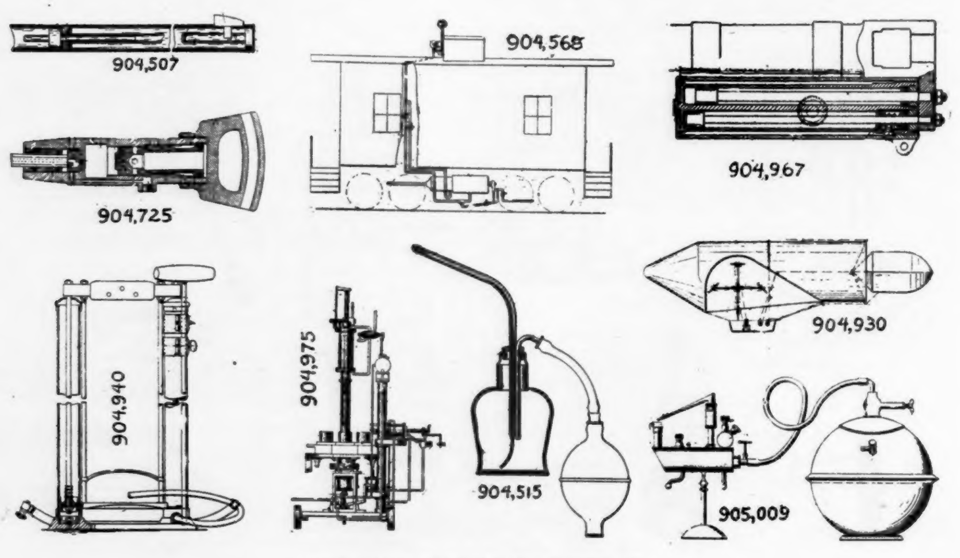


PNEUMATIC PATENTS, NOVEMBER 17.

904,436. ROCK-DRILL. JOHN H. HUHN, Fairmont, W. Va.
904,459. PISTON INLET-VALVE. HENRY C. SERGEANT, Westfield, N. J., assignor to the Ingersoll-Rand Co.

NOVEMBER 24.

904,507. AIR-GUN. WILLIAM J. BURROWS, Plymouth, Mich.
904-568. AIR-BRAKE INDICATOR. ORIE R. SNYDER, Knoxville, Tenn.
904,724. IMPACT-TOOL. CHARLES B. RICHARDS, Cleveland, Ohio.
904,725. IMPACA-TOOL. CHARLES B. RICHARDS, Cleveland, Ohio.
904,726. IMPACT-TOOL. CHARLES B. RICHARDS, Cleveland, Ohio.
904,827. PNEUMATIC IMPACT-TOOL. GEORGE L. BADGER, Quincy, Mass.
904,930. AERIAL SHIP. FRANZ BOLLHORN, Veddel, near Hamburg, Germany.
904,940. AIR-COMPRESING PUMP. SVEN DAHLBERG, Springfield, Mass.
904,967. PNEUMATIC RECUPERATOR FOR RECOIL-GUNS. NOBERT KOCH, Essen-on-the-Ruhr, Germany.
904,975. AUTOMATIC GLASS-MOLDING APPARATUS. FRANCIS J. MACKIN, San Francisco, Cal.
905,009. BRAZIER'S LAMP. JAMES A. SHORES, Crowder, Okla.



PNEUMATIC PATENTS, NOVEMBER 24.